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NAME changed to:

DATA MEASUREMENTS CORP. (DMC)

~~MICOM Inc.~~

changed again 1974

to MICOM?

OPERATING and SERVICE MANUAL

TRW-CSD "R"

model 6100

TEST SET

SERIALS PREFIXED:

039---

MRIOE

MICOM DIVISION 3M
COMPANY

MICOM, INC., 855 COMMERCIAL STREET, PALO ALTO, CALIFORNIA U.S.A. 94303



TM606775

CERTIFICATION

MICOM, Inc., certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when shipped from the factory. MICOM also certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY

All our products are warranted against defects in materials and workmanship for one year from the date of shipment. Our obligation is limited to repairing products that prove to be defective during the warranty period. We are not liable for consequential damages.

LIST OF EFFECTIVE PAGES

TOTAL NUMBER OF PAGES IS 54, AS FOLLOWS:

<u>Page No.</u>	<u>Issue</u>
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ADDENDUM

The following modification has been made to the MICOM Model 6100 Test Set incorporated in the NASA version of the MICOM Model 4001 Magnetic Tape Recorder Calibration and Alignment Test Set.

Two BNC signal connectors have been brought to the rear panel. These are wired in parallel with their associated front-panel connectors (which have not been altered).

<u>SIGNAL</u>	<u>CONNECTOR</u>
Oscillator output	J7R
Input	J9R

The connectors are BNC UG 657/U.

NAME CHANGE

MICOM, Incorporated has changed its name during mid-1969 to Data Measurements Corporation (DMC). Technical manuals may carry either name; however, the equipment is not affected by the name transition.



OPERATING and SERVICE MANUAL

model 6100

TEST SET

SERIALS PREFIXED:

039---

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MODEL 6100 TEST SET

SPECIFICATIONS

OSCILLATOR

Frequency: 10Hz to 10MHz in 6 decade ranges.

Output: 4V rms from 50 ohms. Adjustable to 40dB below full output.

Total Harmonic Distortion: Less than 0.2% from 100Hz to 500kHz; less than 2% from 10Hz to 5MHz; less than 4% at 10MHz.

VOLTMETER

Input Impedance: 1 megohm shunted by less than 50pF.

Input Range: 1mV to 30V rms in ten 10dB steps.

Accuracy: $\pm 3\%$ of full scale at 1kHz.

Frequency Response: +0.5dB, -1dB from 10Hz to 10MHz on 3mV to 3V ranges.
+0.5dB, -1dB from 10Hz to 6MHz on 1mV, 10V, and 30V ranges.

Amplifier Output: 1V rms for full-scale meter reading.

Scale Calibration: 50 divisions, 0-1 scale; 32 divisions, 0-3.2 scale; +2dB to -15dB.

Meter Characteristics: Average responding, calibrated in rms for sinewaves.

WAVE ANALYZER

Frequency Ranges: Measures second and third harmonic distortion of signals with fundamental components from 100Hz to 1MHz.

Range: 3% full scale.

Accuracy: ± 1 dB when reading third harmonics.

AGC Range of Input: 20dB with high and low-level warning lamps.

GENERAL

Power: 115V or 230V, $\pm 10\%$; 48-64Hz. Approximately 40W required.

Ambient Operating Range: 0°C to 50°C.

Front Panel Dimensions: 5.25" x 19" wide.

Cabinet Dimensions: 6.25" x 19" x 13" overall.

Mounting: Bench mount, convertible to rack mount.

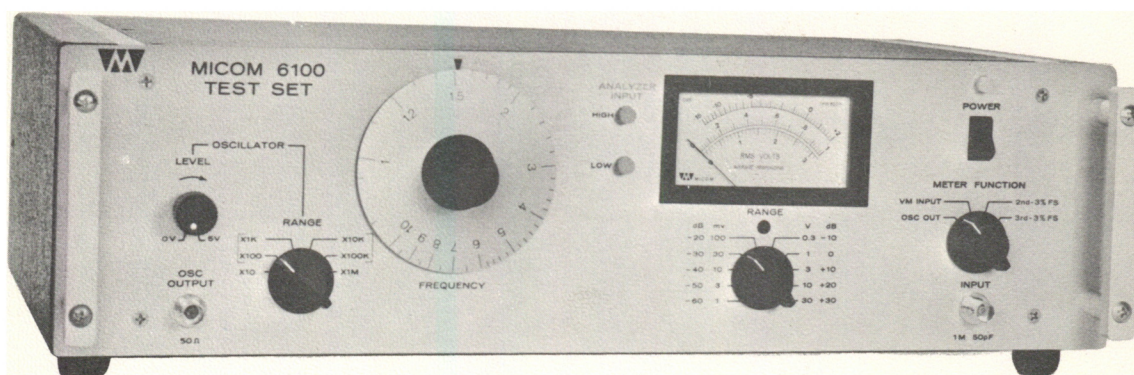
Net Weight: 17 lbs. Shipping Weight: 25 lbs.

Specifications subject to change without notice.

Made in U.S.A.
April 1969

SECTION I

GENERAL INFORMATION



DMC Model 6100 Test Set

1-1 DESCRIPTION

The Model 6100 Test Set is a multipurpose instrument, which combines in one package a wideband (10Hz - 10MHz) low distortion signal generator, a 1mV - 30V ac voltmeter, and an automatically normalized 100Hz - 1MHz wave analyzer. Although primarily designed for use with direct-mode tape recorders, it can also be used with FM equipment and as a convenient means of evaluating any network or system where gain, harmonic distortion, and signal-to-noise ratio are of interest. The test set has been human engineered to reduce patching and controls needing adjustment to a minimum, thereby speeding test and alignment procedures.

Record and bias level adjustments and harmonic distortion measurements can be made quickly and accurately with the Model 6100. Second and third harmonic distortion is easily determined, with test results displayed directly in percentage on a panel meter without interacting level adjustments. The test set feeds a measured signal to the system under test and analyzes the response. Since all switching is internal, only two connecting cables are needed. The keys to faster and more accurate harmonic distortion measurements are the internal automatic level correction circuit that allows a 20 dB variation in the input fundamental level without any readjustments of the Model 6100, and a wave analyzer that automatically tracks either the second or third harmonic. This greatly shortens test time. Front panel controls permit rapid selection of internal circuits, meter ranges, levels and frequencies. Panel markings and groupings are designed for operator convenience.

SECTION II

INSTALLATION

2-1 INSPECTION

This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of scratches or defects, and in perfect electrical order upon receipt. To confirm this, inspect the instrument for physical damage received in transit. Also, test the electrical performance of the instrument (see Section V). If there is damage or deficiency, see the warranty on the inside of the front cover.

2-2 CLAIM FOR DAMAGE IN SHIPMENT

Your instrument should be inspected and tested as soon as it is received. Refer to Section V, Performance Checks and Calibration. The instrument is insured for safe delivery. If it is damaged in any way, or fails to operate properly, file a claim with the carrier or, if insured separately, with the insurance company.

2-3 POWER REQUIREMENTS

The Model 6100 operates from either 115 or 230V ac, 50 - 60 Hz. To convert from 115 to 230V operation, change the position of the slide switch (located on the rear panel) so the designation exposed on the switch matches the nominal power line voltage. Use a 3/4 ampere, slow-blow fuse for 115-volt operation, or a 3/8 ampere, slow-blow fuse for 230-volt operation.

2-4 THREE-CONDUCTOR POWER CABLE

To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. All DMC instruments are equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground wire.

To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong adapter to ground.

2-5 INSTALLATION

The Model 6100 is fully transistorized and, therefore, requires no special cooling. However, the instruments should not be operated where the ambient temperature exceeds 50°C (122°F).

2-6 RACK/BENCH INSTALLATION

The Model 6100 is shipped as a bench type instrument, with rubber feet. To mount the instrument in a standard 19 inch relay rack, remove the side castings. Two 10-32 screws in each handle and one side mounting screw to the rear attach each casting to the instrument. Use the screws in the handles to fasten the instrument in a rack.

2-7 REPAIR AND SERVICE

If repair or service is required, contact our representative in your area or the factory. Do not return the instrument without our authorization. In many cases, we will be able to supply you the information necessary to repair the instrument or will provide a printed circuit card to replace the malfunctioning card.

If it becomes necessary to return the instrument to the factory for repair or service, attach a tag to the instrument, identifying the owner and indicating the service or repair to be accomplished. Include the model number and serial number of the instrument on the tag, and also in any correspondence.

In repackaging for shipment, use the original container if available. If the original container is not available, package the instrument as follows:

A. Wrap the instrument in heavy paper or plastic before placing it in an inner container.

B. Use plenty of packing material around all sides of the instrument and protect the panel components with cardboard strips.

C. Place the instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

D. Mark the shipping container with "Delicate Instrument," "Fragile," etc.

Ship the instrument prepaid, preferably via air freight, to:

Service Department
Data Measurements Corporation
855 Commercial Street
Palo Alto, California 94303

SECTION III

TABLE 3-1 DIRECT - RECORD PARAMETERS

Low Band

Tape Speed ips	± 3 -dB Pass Band Hz*	Record Bias Set Frequency Hz overbias 3 dB**	Record Level Set Frequency Hz
60	100 - 100,000	100,000 $\pm 10\%$	1000 $\pm 10\%$
30	100 - 50,000	50,000 $\pm 10\%$	1000 $\pm 10\%$
15	100 - 25,000	25,000 $\pm 10\%$	1000 $\pm 10\%$
7-1/2	100 - 12,000	12,000 $\pm 10\%$	500 $\pm 10\%$
3-3/4	100 - 6,000	6,000 $\pm 10\%$	500 $\pm 10\%$
1-7/8	100 - 3,000	3,000 $\pm 10\%$	500 $\pm 10\%$

Intermediate Band

Tape Speed ips	± 3 -dB Pass Band Hz*	Record Bias Set Frequency Hz overbias 3 dB**	Record Level Set Frequency Hz
120	300 - 500,000	500,000 $\pm 10\%$	1000 $\pm 10\%$
60	300 - 250,000	250,000 $\pm 10\%$	1000 $\pm 10\%$
30	200 - 125,000	125,000 $\pm 10\%$	1000 $\pm 10\%$
15	100 - 60,000	60,000 $\pm 10\%$	500 $\pm 10\%$
7-1/2	100 - 30,000	30,000 $\pm 10\%$	500 $\pm 10\%$
3-3/4	100 - 15,000	15,000 $\pm 10\%$	500 $\pm 10\%$
1-7/8	100 - 7,500	7,500 $\pm 10\%$	500 $\pm 10\%$

Wideband

Tape Speed ips	± 3 -dB Pass Band Hz	Record Bias Set Frequency KHz ***	Record Level Set Frequency KHz
120	500 - 1,500,000	1,500 $\pm 10\%$	150 $\pm 10\%$
60	500 - 750,000	750 $\pm 10\%$	75 $\pm 10\%$
30	500 - 375,000	375 $\pm 10\%$	37.5 $\pm 10\%$
15	500 - 187,000	187 $\pm 10\%$	18.7 $\pm 10\%$
7-1/2	500 - 93,000	93 $\pm 10\%$	9.3 $\pm 10\%$
3-3/4	500 - 46,000	46 $\pm 10\%$	4.6 $\pm 10\%$

* Pass Band response is referenced to the output at the Record Level Set Frequency.

** Record Bias current is adjusted for maximum reproduce output at a signal level 5 to 6 dB below Normal Record Level and then increased until an output level 3 dB below the maximum value is obtained.

*** Record Bias current is adjusted for maximum reproduce output at a signal level 5 to 6 dB below Normal Record level and then increased until an output level 1 dB below the maximum value is obtained.

TABLE 3 - 1 DIRECT - RECORD PARAMETERS

SECTION III

OPERATING INSTRUCTIONS

3-1 INTRODUCTION

This section contains operating instructions for the Model 6100 Test Set. Please note that all signal input and output connectors for this instrument are type BNC.

3-2 GENERAL OPERATING INFORMATION

Tape transport speeds and signal frequencies and levels are dictated by industry convention, IRIG standards and recommendations, and manufacturers' specifications; however the test set's wide range of usefulness will permit fast and thorough testing of most tape systems. It should be noted that, in addition to its function as a wave analyzer, the instrument serves as an excellent signal generator and ac voltmeter. (Refer to Specifications, Page 1-1.) When in use as a wave analyzer, the control setting and indicator lamps related to the analyzer mode are accented by green panel markings. The test set generates signals in the range of 10Hz to 10MHz for the input of the recorder channel under test. The signals appear at the OSCILLATOR OUTPUT terminal. The signals are recorded, reproduced, and returned to the INPUT terminal for analysis of harmonic distortion content. The test set voltmeter section can be used to monitor the signal (FUNCTION switch on OSCILLATOR OUTPUT) to the recorder OSCILLATOR OUTPUT terminal), and can also measure the reproduced signals from the recorder (signal returned to the INPUT terminal and FUNCTION switch on VOLTMETER Input). The voltmeter RANGE switch can be readily adjusted to the correct setting by watching the ANALYZER INPUT indicator lamps. Input and output cables from Model 6100 to equipment under test should be RG58/U 50-ohm coax, and no longer than necessary. The instrument's input impedance is 1 megohm, 50 pF max. If cables are excessively long, the total capacitance will seriously affect the high frequency characteristics to the test set. If cables must be used, the input and output cables should be properly terminated with 50-ohm resistors.

3-3 CONTROLS AND INDICATORS

Figure 3-1 illustrates and describes the function of all front and rear panel controls, connectors, and indicators. Normal selector positions related to distortion measurements are denoted by green panel engraving.

1. The FREQUENCY dial adjusts the Test Oscillator Frequency.
2. The LOW lamp glows to indicate that the voltmeter input level is too low at the INPUT during distortion test, the voltmeter RANGE switch must be rotated CCW until the lamp goes out.
3. The HIGH lamp glows to indicate that the voltmeter input level is too high during distortion test, the meter RANGE switch must be rotated CW until the lamp goes out.
4. The multi-purpose meter indicates ac signal voltages or harmonic distortion, depending on settings of the METER FUNCTION selector. The signal indicated on the meter may also be displayed on an oscilloscope when connected to the SIG OUT connector on rear of the instrument.
5. The POWER switch turns on instrument ac power.
6. The POWER indicator lamp glows when power is applied.
7. The METER FUNCTION switch connects the meter to measure the following:
 - a. signal directly across the OSC OUTPUT connector.
 - b. input signals connected to the INPUT connector below.
 - c. second harmonic distortion in the 2nd - 3% FS position.
 - d. third harmonic distortion in the 3rd - 3% FS position.
8. The INPUT connector accepts external signals for the voltmeter and distortion analyzer circuits.
9. The mechanical zero adjustment is used to zero-set the meter with power off.
10. The voltmeter RANGE switch selects full scale ac voltmeter sensitivity from 1mV to 30 V. During harmonic distortion measurements, the ANALYZER INPUT LOW AND HIGH indicator lamps assist the operator in locating the correct switch setting.
11. The OSCILLATOR RANGE switch permits decade switching of the Test Oscillator from 10Hz to 10MHz. In the X100 through X100K ranges, the switch provides simultaneous decade switching of the wave analyzer depending on the harmonic test setting of the METER FUNCTION switch.

SECTION III

12. The LEVEL potentiometer adjusts the output level of the Test Oscillator over a range of 0 to 4 volts rms from a 50-ohm source (2 V rms into a 50-ohm load), and includes a switch that disconnects the oscillator in the maximum CCW position.
13. The OSCILLATOR OUTPUT connector connects the output of the main oscillator (from 50 ohms) to equipment under test.
14. The line voltage (115V/230V) switch sets the instrument to operate from 115V to 230V ac power line.
15. The fuse provides power line protection.
16. The SIG OUT connector permits connection of the oscilloscope for visual display of the signal shown on the meter.
17. The ac power connector provides input connections for ac power.

3-4 PRELIMINARY ADJUSTMENT

The test and alignment procedures to follow are based on principles of good engineering practice and the recommendations contained in IRIG Telemetry Standards 106-66. Table VIII of the IRIG publication is reproduced in part as Table 3-1 of this manual. Individual requirements and manufacturers' specified procedures may differ to a considerable degree; therefore, in general, the operator should refer to available specific recommendations for his tape system concerning correct test frequencies, upper frequency limits and their related tape speeds, normal recording and playback levels, head alignment instructions, and effective head and tape degaussing methods. Previous experiences and conclusions on the part of the operator will prove helpful in developing new and simplified methods of recorder testing using the Model 6100.

Before proceeding with tests and measurements, be sure the heads, guides, and rollers are thoroughly demagnetized and that the tape to be used is completely degaussed. Also make sure that the heads, guides, and rollers are clean and that all equipment components such as amplifiers and equalizers are selected to constitute a working system at the desired tape speed. The use of high-quality, bulk-erased tape in the following tests removes a considerable source of error and assists in obtaining repeatable tests and measurements. Uniform test results are essential for establishing simplified and meaningful maintenance records. All of the adjustments, alignments, and tests described in this section are dynamic operating tests, involving use of record/reproduce amplifiers, and with tape transport in operation. The recorder/reproducer and tape are evaluated as an integrated unit.

3-5 ADJUSTMENT AND ALIGNMENT OPERATING PROCEDURES

The following are progressive instructions for using the Model 6100 for head alignment, bias level adjustment, reproducing

equalizer response, flatness checks, harmonic distortion measurements, and overall system frequency response evaluation.

The procedures should be conducted at regular intervals, or whenever degraded output data is observed or suspected. We recommend that the procedures be conducted in the order given. All of the procedures are based on the standard equipment setup as shown in Figure 3-2.

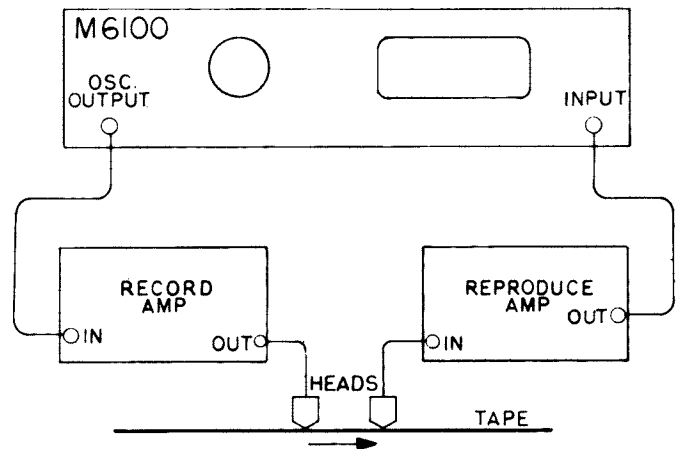


FIGURE 3-2 TEST EQUIPMENT SET-UP

3-6 HEAD ALIGNMENT

In general, wideband instrumentation records (1MHz to 2MHz at 120 ips) require reproduce head alignment. Head alignment in instrumentation recording equipment generally consists of proper orientation of the playback heads in relation to the fixed position of the recording heads. The heads are aligned as follows:

1. Connect the OSCILLATOR OUTPUT of the Model 6100 to the Input of an odd-numbered recorder channel located at about the middle of the tape.
2. Connect the output of the related reproduce channel to the INPUT.
3. Set the METER FUNCTION switch to the OSC OUTPUT position.
4. Set the OSCILLATOR RANGE and FREQUENCY controls to the upper frequency band edge, according to the tape speed to be used. (Refer to the manufacturer's recommendations or Table 3-1 of this manual.)
5. Adjust the OSCILLATOR LEVEL and record level controls for a recording level approximately 6 dB below the normal recording level.
6. Set the METER FUNCTION selector switch to VMINPUT. If desired, connect an oscilloscope to SIG OUT at the rear of the test set, or in parallel with the Model 6100 INPUT connector.

7. Start the recorder in the record mode to simultaneously record and reproduce the above signal. Adjust the playback level and the voltmeter RANGE switch for a convenient mid-scale meter indication. Avoid excessive playback signal levels which will introduce clipping and waveform distortion (which is easily detected on the oscilloscope).
8. Adjust the screw which positions the odd-numbered heads for maximum output indication on the LEVEL meter.
9. Reconnect input and output cables from the test set to an even-numbered channel of the recorder and repeat step 7. Adjust the positioning screw for the even-numbered heads for maximum output as before.

NOTE

Most recorders require additional compromise head alignment. For compromise head alignments, repeat steps 8 and 9 for several odd-and even-numbered channels. See the instructions for your recorder to find out the proper procedure. Should the tape run out during this or the following tests, the tape should be rewound and thoroughly degaussed before continuing.

3-7 BIAS LEVEL ADJUSTMENTS

Bias level adjustments set the individual current to each channel of the record heads. For these adjustments, we assume that the master bias oscillator is operating normally. The same equipment setup (see Figure 3-2) and test equipment control settings as used in the head alignment procedure are used for these adjustments. Adjustment conditions agree with data in Table 3-1, but may be altered to suit specific manufacturer's recommendations. The bias current for each channel is to be adjusted.

1. Connect input and output cables to the selected channel, with the tape transport running in the Record/Reproduce mode. Select the bias set frequency, as shown in the third column of Table 3-1 or from the operating instructions for your recorder, to match the tape speed used. Set the OSCILLATOR RANGE and FREQUENCY controls of the test set to this frequency.
2. With the OSCILLATOR LEVEL control and the record amplifier gain control set to a record level approximately 6 dB below the full-scale record level, rotate the related channel bias level control to the minimum bias level position (usually CCW) and observe the decrease in reproduced signal level. Measure the reproduced signal with the METER FUNCTION switch in the VM INPUT position.
3. Slowly rotate the bias control for an increase until maximum meter indication is obtained. Continue increasing the level beyond maximum indication until the reading is reduced by a factor of 1 dB or 3 dB (see overbias notes in Figure 3-1, or manufacturer's recommendation). If

specific information is lacking, use the 1 dB overbias factor for wideband recorders and 3 dB for intermediate band recorders. This adjustment sets the optimum operating point for the channel and the tape used in the test.

4. Repeat steps 2 and 3 for each channel until all bias adjustments are uniform. On completion, stop the recorder.

3-8 PRELIMINARY CHECK

At this point establish that the reproduced levels at the record level (distortion set) frequency and its third harmonic are within 1 dB of each other. Make minor adjustment if required.

3-9 DISTORTION MEASUREMENTS

Harmonic distortion measurements are made by recording a sinewave signal, reproducing it, and measuring the second and third harmonic products. The measurements are considerably simplified by use of the Model 6100 Test Set.

Third harmonic distortion is intrinsic in magnetic recording, and is used to set the proper recording level. Second harmonic distortion results from circuit distortion or dissymmetry in the bias waveform. It may also be caused by magnetized record or reproduce heads, poorly erased tape, or magnetized tape guides and rollers.

The Model 6100 contains the signal source and wave analyzer essential for these tests. All functions are front-panel controlled. The input and output cables that connect the test set to the recorder under test provide all necessary connections without additional patching. Distortion is indicated directly in percentage on the test set panel meter.

Distortion measurements are independent of level at the Model 6100 INPUT when the signal is within the AGC range of the instrument as indicated and when neither the HIGH nor the LOW indicator lamp is lit.

3-10 HARMONIC DISTORTION MEASUREMENT PROCEDURE

Proceed as follows, without changing the former test setup (Figure 3-2), with input and output cables connected to the first channel to be tested.

1. Select the tape speed.
2. Set the METER FUNCTION selector to the OSC OUTPUT position.
3. Set meter RANGE selector to display the desired recorder input signal between 1/3 scale and full scale.
4. Set the OSCILLATOR RANGE selector and FREQUENCY control to the proper record level set frequency, either as specified by Table 3-1 or by the recorder manufacturer's operating instruction.
5. Adjust the OSCILLATOR LEVEL control to the desired full-scale record level.

SECTION II:

6. Set the METER FUNCTION selector to the VM INPUT position.
7. Set the meter LEVEL selector to display a normal reproduced signal between 1/3 scale and full scale (check the normal output level for your recorder).
8. Start the recorder in the record/reproduce mode, and adjust the reproduce level control for 1/3-scale to full-scale indication on the LEVEL meter.
9. Rotate the METER FUNCTION selector to 3% 3rd harmonic position. If either the ANALYZER INPUT HIGH or LOW lamp is lighted, adjust the meter RANGE selector or reproduce gain to extinguish the lamp. Read the percentage of third harmonic distortion directly displayed on the LEVEL meter. If the indication is less 1%, advance the record level control to obtain 1% indication (this is the reference level most often specified). Check the alignment instructions for your recorder.

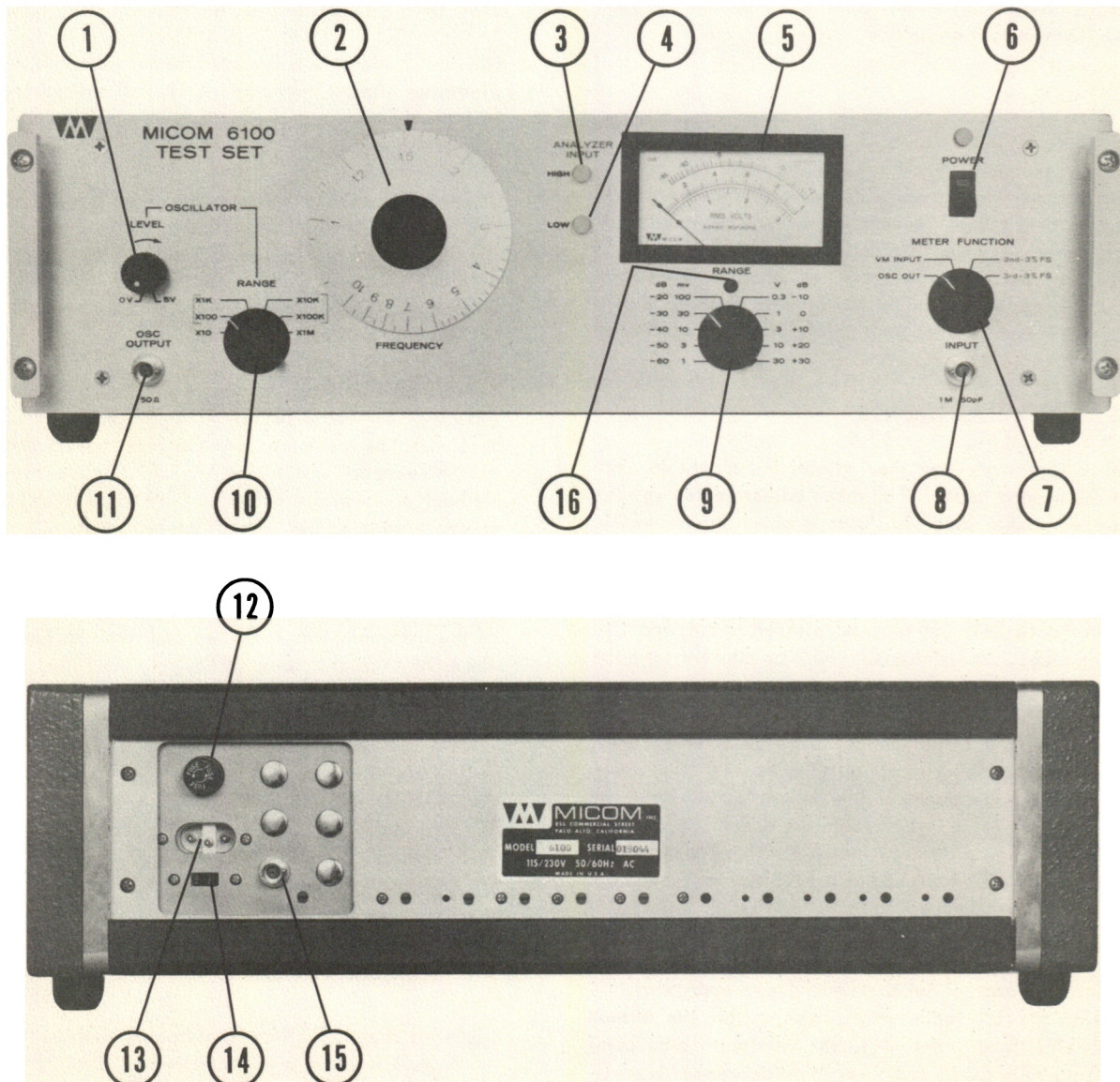


FIGURE 3 -3 FRONT AND REAR PANEL CONTROLS

- ① **OSCILLATOR LEVEL.** Adjusts oscillator output level over a 40 dB range. Maximum CCW position opens switch to provide zero output.
- ② **FREQUENCY** dial sets oscillator frequency in conjunction with RANGE switch.
- ③ **ANALYZER INPUT HIGH** lamp glows to indicate input to analyze is too high. Rotate meter RANGE switch CW until lamp goes out.
- ④ **ANALYZER INPUT LOW** lamp glows to indicate input to analyze is too low. Rotate meter RANGE switch CCW until lamp goes out.
- ⑤ **METER** is multipurpose and indicates either ac signal voltage or distortion depending on position of FUNCTION switch.
- ⑥ **POWER** switch. Turns instrument on and off. Lamp lights to indicate that primary power is applied to instrument.
- ⑦ **METER FUNCTION** switch connects the meter to measure either the oscillator output, ac voltmeter or distortion (2nd or 3rd harmonic).
- ⑧ **INPUT** connector accepts external signals for the voltmeter and distortion analyzer circuits.
- ⑨ **RANGE (meter)** switch provides 10-dB step attenuation from -60 dB to +30 dB (1mV to 30 V) for the ac voltmeter section. During harmonic distortion measurements, the ANALYZER INPUT LOW AND HIGH indicator lamps assist the operator to locate the correct switch setting.
- ⑩ **OSCILLATOR RANGE** switch permits decade switching of the test oscillator from 10 Hz to 10 MHz.
- ⑪ **OSCILLATOR OUTPUT** connector connects the output of the test oscillator from 50 Ω to equipment under test.
- ⑫ **FUSE** provides protection for line and instrument circuits.
- ⑬ **AC POWER CONNECTOR** provides input connections for ac power.
- ⑭ **LINE VOLTAGE (115V/230V)** switch sets instrument to operate from 115V or 230V ac power line. Note that the fuse must be changed when the voltage is changed: 1/2A for 115V, 1/4A for 230V.
- ⑮ **SIG OUT CONNECTOR** permits connection of oscilloscope for visual display of the signal shown on the meter.
- ⑯ **Mechanical zero adjustment**, used to zero-set meter with power off.

NOTE

The AGC action in the Model 6100 compensates for the resulting reproduce level change. Beware of reproduce amplifier clipping and distortion.

10. Rotate the METER FUNCTION selector to 3% 2nd harmonic position and observe the percentage of second harmonic distortion on the LEVEL meter. If the indication is excessive, suspect improperly erased tape, magnetized heads or tape guides, record or reproduce amplifier problems, or trouble in the bias oscillator. Some recorders have a control for minimizing second harmonic distortion. Adjust this control after ensuring that heads or tape guides are not magnetized and that properly erased tape is being used.
11. Set the Reproduce level to the desired output.
12. Recheck third harmonic distortion as in step 9 to ensure that adjustments made in steps 9, 10, and 11 have not changed the third harmonic distortion. If necessary, readjust the record level control to provide the desired distortion reading.

NOTE

Some recorder manufacturers specify a 3% 3rd harmonic distortion setup as normal. Always be guided by your recorder's specifications.

3-11 EQUALIZER FLATNESS CHECK

Proceed as follows, using the same equipment setup (Figure 3-2) as before, with input and output cables connected to one channel and with the recorder in operation.

1. Select the OSCILLATOR RANGE and FREQUENCY settings required for your recorder. Set the METER FUNCTION switch to OSC OUTPUT. Adjust the OSCILLATOR LEVEL to approximately 6 dB below the full-scale recording level.
2. Set the METER FUNCTION selector to the VM INPUT position. Place the voltmeter RANGE selector to the 1V position and adjust the reproduce gain control for 0 dB indication on the RANGE meter. (A 1-volt full-scale output is assumed — change level if necessary to meet a different specified full-scale indication. Some manufacturers run frequency response check at different record and reproduce levels. See your instruction manual).
3. Without changing the oscillator output level, change frequency and adjust the reproduce equalizers to provide a uniform frequency response in accordance with the manufacturer's requirements for your equipment. The oscillator output level should be monitored by placing the METER FUNCTION switch in the OSC OUT position. The reproduced signal level is monitored by placing the

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METER FUNCTION switch in the VM INPUT position. Note that, since the same meter is used for both input and output level measurements, the effects of meter frequency response cancel.

4. Reset the reproduce gain control for proper reproduced signal level.
5. Repeat steps 2 and 3 for the reproduce equalizer in each of the remaining channels.

3-12 FREQUENCY RESPONSE CHECKS

The Model 6100 Test Set enable thorough and rapid determination of overall system frequency characteristics, using the standard equipment setup as in previous tests (see Figure 3-2).

The manufacturer's specific recommendations should be followed for optimum results; the test set provides all necessary functions. If an adequate test procedure is not available, use the following instructions. The test described is an adaptation of the "Frequency Response - Direct Recording" procedure in IRIG Telemetry Standards 106-66, modified to employ the test set as the only required item of test equipment. To check system overall frequency response, connect the equipment to the selected channel, and proceed as follows:

1. Set the OSCILLATOR LEVEL, RANGE, and FREQUENCY controls to the Record Level Set Frequency related to the tape speeds in Table 3-1, at normal record level. Use the METER FUNCTION switch in the OSC OUT position and the voltmeter RANGE switch to establish the OSC OUTPUT level as the recorder input reference.
2. Record and reproduce the signal simultaneously.
3. Place the METER FUNCTION selector in the VM INPUT position and the voltmeter RANGE selector in the appropriate range position. Adjust the reproduce gain control to provide a convenient reference indication such as 0 dB with the METER FUNCTION switch in the VM INPUT position. The oscillator output level may be maintained with the METER FUNCTION selector in the OSC OUT position.
4. Record and reproduce the signal while varying the input frequency over the specified frequency band. Note the maximum and minimum meter excursions of reproduce level in dB. Compare with the reference level in step 3. Maximum allowable excursions depend on the recorder manufacturer's specifications but generally do not exceed ± 3 dB.

SECTION IV

PRINCIPLES OF OPERATION

4-1 INTRODUCTION

This section contains a functional analysis of the Model 6100 Test Set, followed by descriptions of each type of circuit used in the instrument. Descriptions are supported by system block diagrams, with references to the schematic diagrams in Section VI.

4-2 FUNCTIONAL ANALYSIS

The test set block diagram shown in Figure 4-1 consists of three functional groups. For clarity, the groups are shown in simplified form in the lower lefthand corner, consisting of the ac voltmeter, the test oscillator, and the wave analyzer. As indicated in the simplified diagram, each of the groups can be used individually as separate instruments or collectively. The latter use is described as follows:

The ac voltmeter measures sinewave signals generated externally or by the test set. Signals are fed to the meter

preamplifier through the ten-step attenuators, which affect the input and output levels of the preamplifier. Two cascaded voltage amplifiers, each with a gain of ten, amplify signals from the preamplifier. The two output circuits of the second voltage amplifier feed the meter driver amplifier and the output buffer amplifier. When the instrument is used for wave analysis, the meter signal is derived from the output of an active low-pass filter, followed by an amplifier with a gain of 20.

The test oscillator generates a wide range of sinewave signals for injection into a tape recorder or other device under test. The oscillator tunes from 10 Hz to 10 MHz in six decade ranges. Since it is intended for use as a reference signal, it has been designed for very low distortion. The output level is variable from 0 to 4 volts rms.

The wave analyzer receives signals from a tape recorder or other device under test for comparison and analysis. The wave analyzer contains a local oscillator, operating selectively in

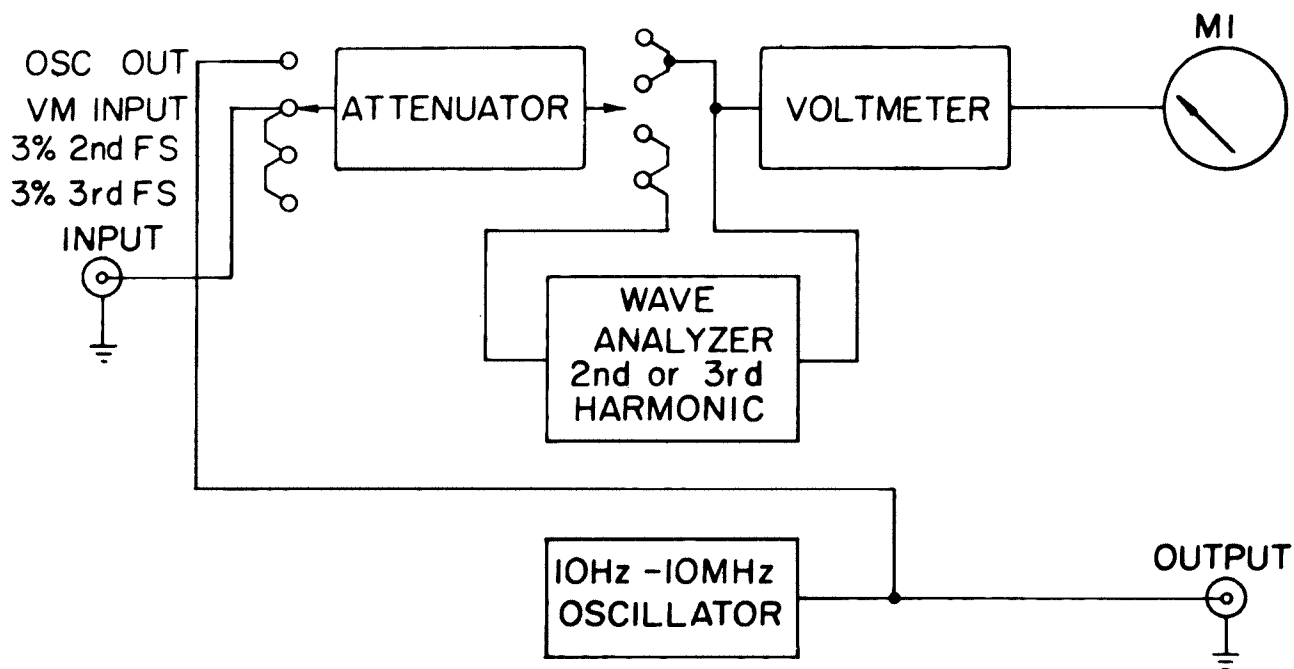


FIGURE 4-1 FUNCTIONAL BLOCK DIAGRAM

SECTION IV

the second or third harmonic mode when compared with the output of the test oscillator, and a linear balanced modulator. The frequency control provides simultaneous tuning of both the test and harmonic oscillators. During analysis, the fundamental and harmonic signals are mixed and the offset signal is demodulated. The offset frequency is the basis for distortion analysis since its amplitude is proportional to the harmonic content generated in the device under test. The offset signal is fed into one of the four low-pass active filters, amplified, and fed to meter circuits for display directly in percentage.

Operating power for all circuits in the instrument is provided by a single regulated power supply that delivers positive and negative 24 volts dc as referenced to chassis ground.

4-3 AC VOLTMETER CIRCUIT ANALYSIS

The ac voltmeter circuit contains five amplifier groups: a preamplifier, two wide-range voltage amplifiers, and two driver amplifiers. The driver amplifiers are used to drive the voltmeter and provide a signal for an external display.

4-4 PREAMPLIFIER CIRCUIT (CARDS 61S4/6131)

The preamplifier section (Figure 6-2) contains an input/output attenuator and an amplifier. The assembly consists of components tightly grouped on two mechanically-coupled circuit cards. Card 61S4 contains the input ten-step attenuator and provides front support for switch assembly S4. The ten-step output attenuator is on the same shaft, but is mounted on the preamplifier card. Its functions will be described later in connection with the preamplifier. A more complete description of the attenuator/preamplifier combination is contained in the test and calibration instructions in Section V.

The second card (6131) contains the input clamp, preamplifier components, and output attenuators (S4-C).

Signals from switch S5 (METER FUNCTION) pass through a protective 10mA fuse (F1) and capacitor C1 to input attenuator switch S4-A (RANGE). Signals below 30mV pass through sections S4-A and S4-B to the preamplifier without attenuation.

For input signals exceeding 30mV, the attenuator ranges are divided into pairs having 20 dB separation; these include the 100 to 300 mV, 1 to 3 volt, and 10 to 30 volt ranges. Separate frequency-compensated attenuators are used for each 20 dB section of the attenuator and provide a constant 1M input impedance.

The preamplifier input is protected against excessive signals by diode clamps. The very high input impedance of FET transistor Q1 produces negligible loading and provides low noise operation in the low frequency region. The feedback amplifier circuit (consisting of Q1, Q2, and Q3) has two normal gain conditions, one having a voltage gain of 10 available at the junction of R9, R11, and R12, for use only on the 1 and 3mV ranges. The unity gain condition is available at the junction of R4 and R9 and is used on the remaining ranges. The circuit is designed to provide a nominal output signal

level of 10mV rms for full-scale reading. The output attenuator (S4-C) alternates in 10 dB steps to maintain the proper output level.

4-5 MULTI-AMPLIFIER CIRCUIT ANALYSIS (Card 6136)

The multi-amplifier card contains a group of functionally related wideband amplifiers, with all but one having overall frequency characteristics nearly flat from 10Hz to 10MHz. Switch operation may change the functional operating positions of the various amplifiers relative to one another. This description is based on the amplifier arrangement as shown in Figure 6-3 in Section VI. The units are described in the following order: the X10 input amplifier, the X20 filter amplifier, the double emitter-follower driver, and the meter driver.

THE X10 INPUT AMPLIFIER

This amplifier receives the nominal 10mV signal from the preamplifier (6131). Transistors Q1 and Q2 produce a voltage gain of 10, which results in a 100mV signal at Q2 collector, test point TP-B, and at Pin 3. Q1 base returns to ground through the path provided by the output attenuator in the preamplifier assembly. Current flow through resistor R4 produces operating bias current.

Input terminal Pin 2 is always connected to the preamplifier output. During wideband voltage measurement, the driver output at Pin 3 is switched to card input Pin 8, the input of the X10 intermediate amplifier. In wave analysis, the output at Pin 6 is switched to card input Pin 8, (X10 input) and the output at Pin 3 is switched to the signal input of the balanced modulator card (6134).

THE X20 FILTER AMPLIFIER

This amplifier has a gain of slightly over eighteen. Nominal 5mV signals from the active low-pass filter (1K09-1) are fed to Pin 5. The amplifier consists of dual FETs Q3 and Q4 and the follower stage Q5. Signals from Pin 5 are fed through C8 and R14 to the gate of Q3. Drain signals from Q3 are amplified by Q5 and appear at Pin 6 at a 100mV level. Voltage reference for Q3 is established by the differential action of Q4 and constant voltage source CR2. This amplifier has flat frequency response from 0.5 Hz to 80kHz.

Potentiometer R21 (DS) provides distortion gain adjustment during calibration to standardize the level of 3.16% distortion as a basis for full-scale meter indication. Input and output signals may be analyzed at test points TP-C and TP-D, respectively. During wave analysis, the 100mV signal at Pin 6 is connected by the function switch to the Pin 8 input terminal for additional amplification.

THE X10 INTERMEDIATE AMPLIFIER

This amplifier consists of Q6, Q7, Q8, and CR3. Signals from input Pin 8 are fed through C13 and R28 to the base of Q6. Amplified signals appearing at collector of Q6 are coupled to the base of Q7, from which output signals are fed through C17.

This circuit, having a nominal voltage gain of 10, provides calibrated input signals to the meter driver amplifier and to the double emitter-follower driver. The GS (GainSet) control is connected to Q6 emitter to permit setting the meter to full-scale indication during calibration. At full scale, a 1 volt rms level is provided at Pin 11 for external display.

CR3 determines the operating biases on this circuit. Q8 provides a stabilized current source for output transistor Q7.

THE DOUBLE EMITTER-FOLLOWER DRIVER

This amplifier consists of Q9 and Q14, with CR4 providing a stabilized voltage source. The signals from C17 in the preceding stage are conducted by C19 to the base of Q9. The emitter of Q9 drives the base of Q14 through R45 to provide a buffered, low-impedance output signal at Pin 11 to drive an external display. This amplifier provides isolation and power gain without voltage gain.

METER DRIVER AMPLIFIER

The meter driver amplifier consists of transistors Q10 to Q13, CR5 to CR9, and related components. Transistors Q10, Q13, and Q12 form a series circuit between the positive and negative power sources, through which a nominal 0.030 ampere current flows. Q12 acts as a fixed current source at one end of the series. Q10 at the other end acts as a signal converter, converting input signals to changing current values.

Q10 and Q13 are cascode connected with operating bias determined and provided by CR5, CR6, and R49. Q13 is a grounded-base amplifier stage, with its base maintained at ac ground potential by C24 and CR6. Input signals on the base of Q10 are converted to changing signal currents, which appear at the outputs of Q10 and Q13 and on the base of Q11. Current changes at the input of Q11 cause changes in the emitter current through R46 and R47 to change the dc bias on Q10, thus forming a feedback control loop that sets the operating point for the entire circuit. AC signals present in R46 and R47 are bypassed to ground through C23. Emitter-follower Q11 provides an isolated low-impedance source of bias for the feedback circuit elements.

With no input signals present, the meter indication is zero. When a signal within the operating range of the instrument is fed to the base of Q10, a current change appears at the output of the cascode pair Q10 and Q13. This signal cannot flow through Q11 or Q12 because of the high impedance they present; but a lower-impedance path is provided by the circuit which includes CR7, CR8, CR9, R57, and capacitors C25 and C26. These components provide a full-wave rectifier function, the action of which is detailed in Figure 4-2. A low-impedance path is provided by the diodes and the high-value capacitors, enabling current to flow through R57, and developing the necessary voltage drop across the resistor. Both the positive and negative signal pulses add in the resistor and the resulting voltage is fed through R56 and R58 to the 200 μ A full-scale deflection meter.

Design characteristics of the meter circuit call for full-scale

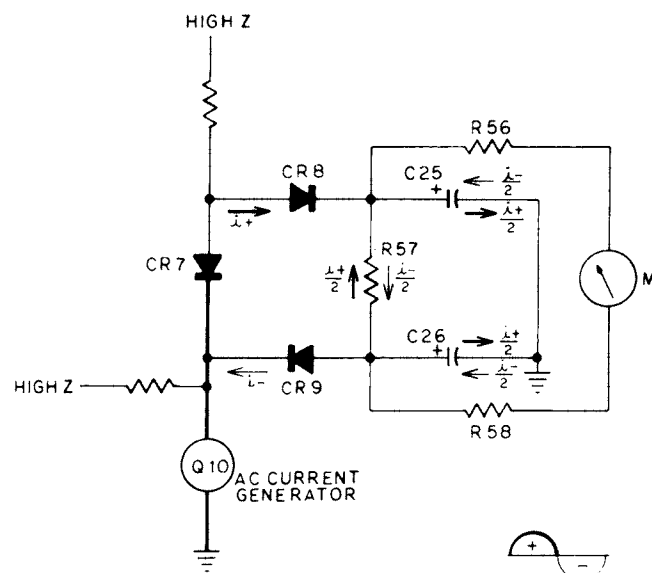


FIGURE 4 - 2 METER AMPLIFIER AC CURRENT FLOW

meter reading with an input signal of 1 volt at the base of Q10. The VFS (Voltmeter Full-Scale) adjustment is used during calibration to set full-scale indication.

Ferrite bead inductors are provided at the base of Q10 and Q12 and emitter of Q13 to prevent switching transients from entering the measurement circuits.

Capacitors C2, C3, C28, and C30 are used to linearize the high-frequency response characteristics of the meter amplifier circuits.

4-6 TEST OSCILLATOR (Card 6135)

The test oscillator (Figure 6-4) provides stable, accurately-calibrated signals throughout the range of 10Hz to 10MHz, continuously variable in six decade ranges.

The oscillator assembly is completely solid-state in design, employing an asymmetrical Wien bridge for the frequency determining element. In addition to the mechanically switched components of the bridge, the test oscillator contains the active elements, a buffer stage, an automatic attenuator, a peak detector circuit, an output level control, and power amplifier.

OSCILLATOR CIRCUIT

The oscillator circuit comprises the first three sections of variable capacitor C1, transistors Q1 through Q5, and their circuit components. The sections of C1: C1A, C1B, and C1C, are located toward the front panel of the instrument. The circuit also includes variable capacitors, and precision resistors connected into the circuit when needed by the rotary selector switch S2. (Refer to Figure 6-8 for connection details concerning C1 and S2.)

The operation of the circuit components as a bridge oscil-

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lator is more easily seen in the simplified circuit arrangement shown in Figure 4-3, in which component designations agree with those shown in card 6135 schematic drawing (Figure 6-4). The arms of the bridge between points A-B-C are the elements that are placed in the circuit by the operation of C1 and S2. The upper right arm is precision resistor R13. The lower right arm is composed of the elements shown, including FET transistor Q6, which is being used as a variable resistor.

Input FET transistor is used to prevent loading of the passive bridge elements (see schematic diagram). It operates as an impedance transformer to drive the base of Q2. The Q1 source is coupled to the base of Q2, part of differential pair Q2 - Q3. Q5 is an emitter-follower acting as output stage of the differential amplifier. Q4 provides a current source for Q3 and appears as a high impedance to Q3 collector to reduce loading.

BUFFER AMPLIFIER

The buffer amplifier consists of the fed-back pair Q9 - Q10 and current source Q11. Signals from the bridge section of the card enter the base of Q9 through R18. The signals are amplified and fed to the base of Q10. Part of the output at the collector of Q10 is returned to the emitter of Q9 through R25. Q11 provides a very high-impedance source for the collector of Q10. The sinewave output of the oscillator appears at Pin E at a level set by R46 (see next paragraph) to 1.2V rms. The gain of the stage is determined by R25 and R23.

PEAK DETECTOR

The peak detector is composed of transistors Q6, Q7, and Q8. Its function is to provide a constant oscillator output level; the control action is explained as follows: A constant flow of current exists in emitter resistor R42, which is common to Q7 and Q8. All of this current normally flows through Q8; Q7 is normally cut off. Variable resistor R46 sets the dc level for external signals to affect the base of Q8. Negative peaks turn off Q8, and all of the current flowing through R42 now flows through Q7; the current pulse is filtered by C19, R41, C18, R38 and R39, and fed to the gate of Q6. This dc voltage changes the resistance of Q6 in order to maintain the balance of the bridge.

4-7 POWER AMPLIFIER (CARD 6137)

The power amplifier assembly is located directly behind the front control panel under the OSCILLATOR RANGE selector switch shaft. The amplifier provides a buffered, isolated output signal for the test oscillator.

The 1.2-volt rms signals from the test oscillator are fed through the 500-ohm potentiometer R1 to the IN card terminal, through C1 and R1, and to the base of transistor Q1. Q1 is the first part of differential amplifier pair Q1 - Q2. The amplified output of Q1 collector is connected directly to base of Q3. Q3 output is emitter-coupled to the grounded-base amplifier-driver Q4, which in turn drives the complementary pair power amplifier Q5 - Q6. The sinewave output appears

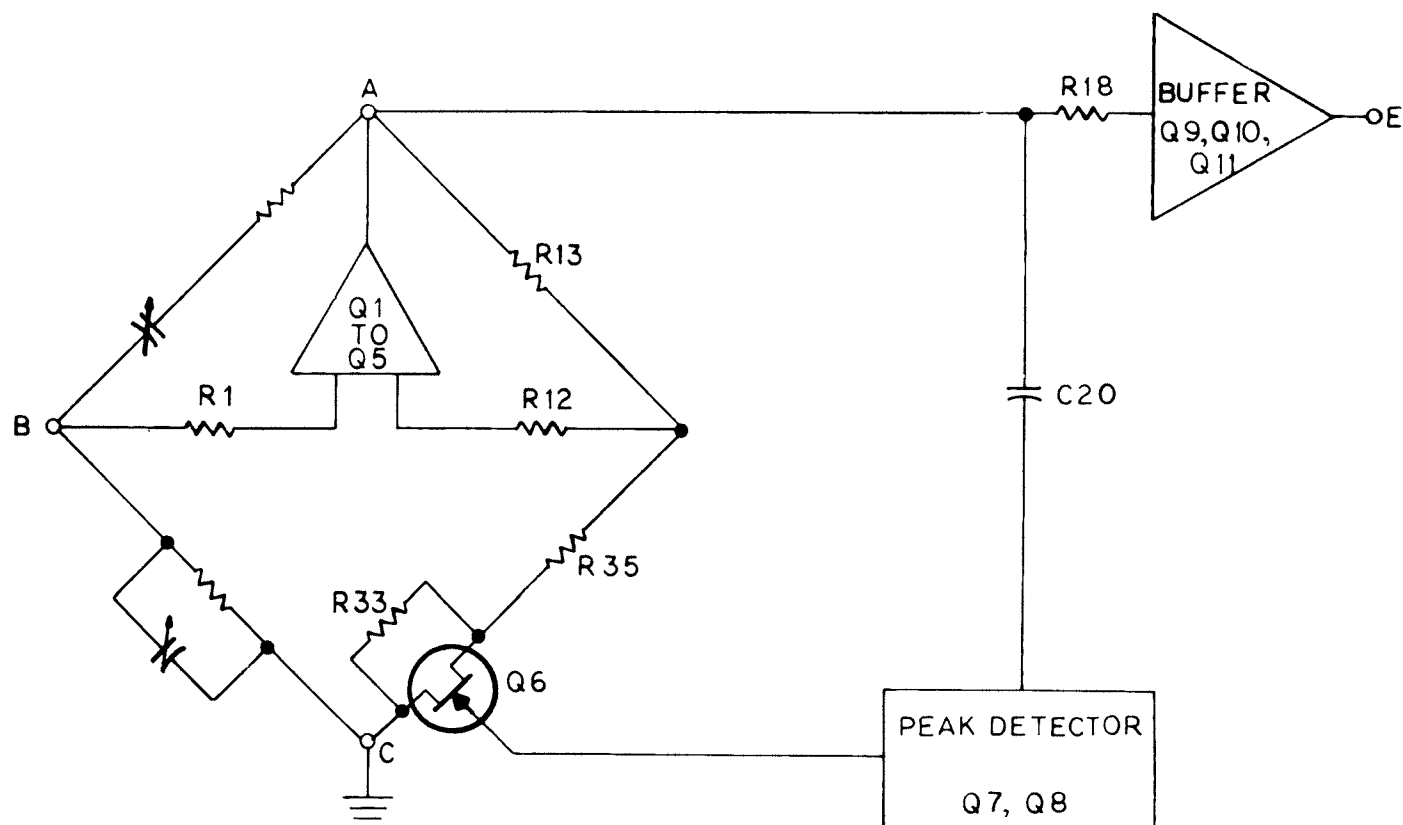


FIGURE 4 - 3 WIEN BRIDGE OSCILLATOR ARRANGEMENT (6135 Card)

at the common emitters of Q5 - Q6, fed through R27 and K1 to the OUT terminal at a 0-to-2.5 volt rms level into a 50-ohm load.

Potentiometer R15 ZS (Zero Set) adjusts the dc bias on the base of Q2 to adjust its current in order to remove the dc offset component from the output signal.

K1 (a reed type relay mounted on card 6137) normally operates in the closed position to allow signal flow, but opens the circuit when the OSCILLATOR RANGE selector switch is in motion. The relay is controlled by a micro-switch actuated by a cam on the RANGE switch. After the switch is at rest, an R-C network provides a two-second delay before the connection is restored to permit signal stabilization and to eliminate transient signal voltage at the output.

4-8 WAVE ANALYZER

The wave analyzer assembly, when combined with the voltmeter and test oscillator sections previously described, provides the system capability needed for measurement of harmonic distortion. The measurement is made by introducing a signal into the wave analyzer assembly for analysis. The measured harmonic distortion is displayed on the test set voltmeter. The instrument has the capability of measuring 2nd or 3rd harmonic distortion in the frequency range from 100Hz to 1MHz.

The assembly contains a local oscillator, a frequency comparator, a balanced modulator, an AFC circuit, a low-pass filter group, and signal level sensors and indicators. For ease of description, the operating groups of the wave analyzer will be presented in functionally related groups in order of signal flow in the following group sequence: Signal Normalization, Signal Demodulation, and Oscillator AFC Circuits.

SIGNAL NORMALIZATION GROUP

This functional group consists of a portion of the circuit elements located on the balanced modulator card 6134 (Figure 6-10). This group processes the nominal 100mV incoming signal from the preamplifier stages into a constant-amplitude 60mV signal, to eliminate the necessity of rechecking the reference after varying the input signal level.

The input signal enters the card at terminal 2 from switch C5-C (see Figure 4-1) and is fed through C1 and R1 to transistor Q2. The Q2 input circuit is shunted by the series circuit formed by C2 and FET Q1, which functions as a variable loss circuit controlled by a feedback loop, the description of which follows:

The signal is amplified by the feedback pair Q2 - Q3. The output at the collector Q3 is fed into two circuits; another feedback pair Q6 - Q7, and the modulator section of the card. After amplification in Q6 and Q7, the signal has an amplitude of approximately 1 volt rms. The signal is applied to input capacitor C27 and to the base of Q8 of the AGC section. Q8 is a phase-splitter which delivers two out-of-phase signals to the bases of the full-wave rectifier pair Q9 and Q10. Negative

half-wave pulses appear at the common collectors of Q9 and Q10, depending on the amplitude of the input signals, and are filtered by C30 into a varying negative dc signal that is fed to the base of Q11. Q11 and Q12 form a level sensing circuit, with its sensing level determined by R83 potentiometer setting which sets Q12 dc base voltage. Increased signal at base of Q11 causes the base to become less positive, allowing Q11 to conduct and cut off Q12 as the emitters approach ground potential. As Q12 cuts off, its collector becomes less positive as a result of an increased input signal. This varying dc voltage is applied to emitter-followers Q13 - Q14, which buffer the signal, and then to the gate of FET Q1, changing its resistance to correct any signal level change at the base of Q2. This feedback loop has the overall effect of providing a constant AGC signal to the analyzer circuits, and is effective over an input voltage range of about 20dB.

When input signal levels are within the 20dB range, both the HIGH and LOW ANALYZER INPUT indicator lamps are off. The changing AGC signal from the emitter of Q14 is fed to the base of Q15, which is coupled to Q16. Q15 - Q16 and CR3 constitute a high-level signal sensing circuit that lights DS2A to indicate too high an input signal level to be AGC'ed. The same AGC signal from Q14 is fed to the low-level sensing circuit composed of Q17, Q18, Q19, and CR4, which lights DS3A when the input signal is too low. Q16 and Q19 are lamp drivers. The indicators simplify wave analysis by warning the operator that the signal is outside the 20dB AGC range of operation.

DEMODULATION GROUP

This group combines two distinct but harmonically related input signals and produces a demodulated output signal. The portion of the group mounted on card 6134, Figure 6-10, contains an MS (Modulation Set) control, two phase splitters, an integrated circuit balanced modulator, and two balance controls. Circuit operation is described as follows:

The normalized 60mV signal from Q3 is fed to the MS potentiometer R12, through capacitor C7 and R14 to the base of the phase splitter transistor Q4. Out-of-phase signals from Q4 collector are fed through C8 to the bases of the double differential amplifier pair contained in A-1 through IC terminals 7 and 10. The in-phase signal from Q4 emitter is fed through C9 to the other bases of the differential amplifier pairs through IC terminals 1 and 4. The base bias adjustment needed for balancing each differential amplifier is provided by R19 and R20. Balancing of both amplifiers to cancel the fundamental at the output is provided by R43 SB (Signal Balance).

The signal from the local oscillator enters the card at Pin 11 and is fed through C10 and R21 to the base of Q5 phase splitter to provide two out-of-phase signals, which are fed to the emitters of the current source transistors in the IC modulator A1.

For harmonic distortion analysis, the frequency of the local oscillator is locked at either the second or third harmonic of the test oscillator by the frequency comparator, to be dis-

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cussed later. Furthermore, since third order harmonic distortion is inherent in tape recording, and because some degree of second order harmonic distortion may exist in system electronics, the reproduced version of the test oscillator signal contains some harmonic distortion.

The harmonic analysis process used in the Model 6100 may be compared with superheterodyne receiver theory in which an incoming signal containing information is detected and mixed with a signal from a local oscillator, filtered, and demodulated in order to provide an output. The test oscillator feeds a signal to the recorder. After the signal is reproduced, it becomes the incoming signal mentioned above; the degree of distortion it has undergone is the desired information.

A typical distortion analysis is presented in the following example, with a 1kHz test frequency used:

Assume: Test Oscillator f 1kHz (a)
 Second Harmonic $2f$ 2kHz
 or Third Harmonic $3f$ 3kHz

To either $2f$ or $3f$, an offset signal of 100Hz is added, causing the actual output frequency of the local oscillator to be either:

$2f + 100\text{Hz}$ 2.1kHz (b)
 or $3f + 100\text{Hz}$ 3.1kHz (c)

Signal (a) may be mixed with either signal (b) or (c) to produce a variety of products that could be used. However, for simplicity of processing, the common lowest-frequency product is selected and used:

$2f + 100\text{Hz} - 2f$ 100Hz
 or $3f + 100\text{Hz} - 3f$ 100Hz

This 100Hz signal is passed through a low-pass filter to reduce noise and unwanted products. The filter used in this range of tests has a bandwidth of approximately 313Hz, so the signal is well within its passband.

Thus harmonic products which have been added to the 1kHz test signal in the record/reproduce process are demodulated at the offset difference frequency, whose amplitude is proportional to the desired product. This appears at the output of the low-pass filter and is amplified and displayed on the panel meter.

Tests performed at other frequencies are made in the same manner. Four filters of different frequencies are used to enable distortion testing over the entire range of 100Hz to 1MHz. Four different offset frequencies are added to determine the local oscillator output frequency. They are added as fixed amounts to the harmonic frequency for a given range. The offset frequencies employed represent fixed quantities of cycles that are added to the harmonic frequency at any portion of its related operating frequency range. The offset frequencies employed represent an approximation of one-third the numerical value of the bandwidth of the filters used in related measurements ranges. Table 4-1 shows the rela-

relationships existing between the test ranges, the filter bandwidths, and approximate offset frequencies.

Table 4-1

Test Range	Filter Bandwidth	Offset Frequency
100Hz - 1kHz	31.3Hz	10Hz
1kHz - 10kHz	313.0Hz	100Hz
10kHz - 100kHz	3.13kHz	1000Hz
100kHz - 1MHz	6.26kHz	2000Hz

Table 4-2 exemplifies the typical offset frequency relation to the local oscillator frequency over the third range in Table 4-1. Note the numerical addition of the offset to the harmonic frequency.

(Third Harmonic Test) Table 4-2

Test Oscillator	Harmonic Frequency	Offset	Local Oscillator
10kHz	30kHz	1kHz	31kHz
30kHz	90kHz	1kHz	91kHz
60kHz	180kHz	1kHz	181kHz
100kHz	300kHz	1kHz	301kHz

4-9 LOW PASS FILTERS (Card 1K09-1)

This card (Figure 6-9) contains four active filters of identical design for 31.3Hz, 313Hz, 3.13kHz, and 6.26kHz bandwidths. The transmission characteristics of the filters are shown in Figure 4-4. The filters are identical in design except for the components used to establish various bandwidths, so the action of only one filter will be presented.

The passband performance is controlled by C1, C2, C3, R1, and R2 in the first section, and by C4, C5, C6, R8, R9, and R10 in the second section. The filters provide a voltage gain of approximately 4.3.

The OSCILLATOR RANGE switch connects the output of the balanced modulator to the input of the selected filter in all but the first and sixth ranges. The nominal 5mV output of the filter is applied to the X20 FET amplifier on card 6136.

4-10 LOCAL OSCILLATOR (CARD 6135-1)

The local oscillator (see Figure 6-6) provides stable output signals harmonically related to the signals from the test oscillator. The local oscillator generates signals that are either the second or third harmonics plus a fixed offset selected by the four intermediate settings of the OSCILLATOR RANGE switch S2, and the two last settings of the METER FUNCTION switch S5.

When operating in the second harmonic mode, the oscillator has a tuning range from 200Hz to 2MHz. In the third har-

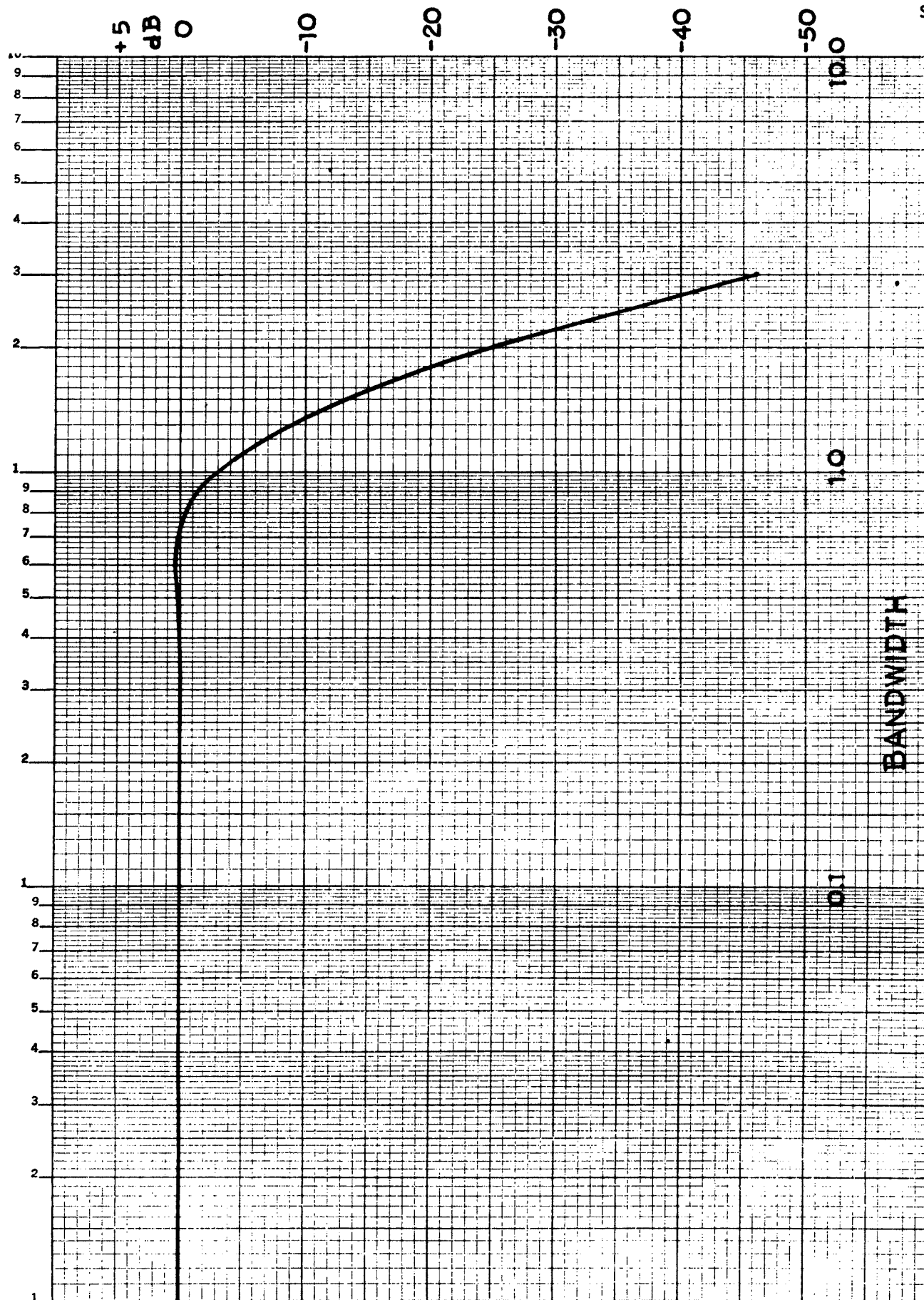


FIGURE 4 - 4 LOW-PASS FILTER CHARACTERISTICS

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monic mode, the tuning range is from 300Hz to 3MHz.

The local oscillator is similar in design and operation to the test oscillator (refer to paragraph 4-6), except that it is a symmetrical Wien bridge circuit. In addition, its normally determined output frequency is increased slightly by the offset amount added and controlled by the AFC circuits contained on card 6132. Output signal voltage at Pin E is set for 2 volts rms, with level control provided by R47. The output signal is fed to the frequency comparator and balanced modulator cards.

4-11 FREQUENCY COMPARATOR (CARD 6133)

The frequency comparator's function is to provide precise frequency relationships between input test signals from the AGC circuits and the signals from the local oscillator. The comparator has two inputs: one accepts the signals from the amplifier in the AGC group (see Figure 6-2) before the signals reach the full-wave detector; the second signal is received from the local oscillator.

The first signal (see Figure 6-7) with an amplitude of approximately 0.5 volts rms enters the circuit card at Pin 4, and flows through C1 and R1 to the base of Q1, which has a voltage gain of about five. The signal is amplified and fed into the input of the Schmitt trigger Q2 - Q3 and CR1 to produce a squarewave output to drive the differentiator circuit C4 and R13; the resulting pulses are fed to input terminal 2 of JK flip-flop A2. A pulse is produced at this point for each cycle of input signal. Input and output measurements can be made at test points A and B.

The second signal input enters the card at terminal 6 from the local oscillator, through C5 and R14 to the input of Schmitt trigger Q4 - Q5 and CR2, to produce squarewaves. These are then fed through C7 and R22 to produce differentiated pulses at the local oscillator frequency. The pulses are fed to both inputs of JK flip-flops A1. The flip-flops are connected to divide either by two or by three, as controlled by the setting of METER FUNCTION switch S5, which changes the bias on terminal 10 of A1. Input and output measurements can be made at test points C and D. Output signals at terminal 14 of upper flip-flop A1 are pulses at the local oscillator rate $f/2$ or $f/3$ and therefore should approximate the input frequency fed to terminal 2 input of A2, except for the presence of the offset frequency in the local oscillator signal.

The upper and lower sections of A2 are used to compare the phase relationship between the two pulse trains. Signals entering trigger terminals 2 and 6 of A2 produce outputs at terminals 14 and 8. These signals are fed to inputs 10 and 9 of gate A3. The output of A3 at terminal 8 is fed to terminals 10 and 12 to reset both flip-flops when both have been toggled. The output is a width-modulated squarewave, with a modulation frequency corresponding to the difference of the two input signal frequencies. This output appears at terminal 9 of A2 and is filtered by R26 and C15. The filtered output is applied to terminal 2 of variable resistor R3, which is ganged to the local oscillator tuning capacitor.

Variable resistor R3 and capacitors mounted on S2-K1 present a changing filter time constant over the tuning range and couple the demodulated difference frequency to the input of Schmitt trigger Q6 - Q7. The shaped output signal of the trigger is fed into differentiator C9 - R33, for conversion to pulse form present at test point H and at input terminal 1 of gate A3. A3 is connected as a bistable multivibrator using positive output logic, with a positive 3.5 volt signal denoting a 1 output.

Circuit operation is as follows: A positive pulse at Pin 1 of gate A3 produces a 0 output at Pins 3 and 6. With Pin 7 normally at 0, a 1 is produced at 5, test point K, and at the base of Q8. The pulse cuts off Q8 and starts the charge cycle to C11 through R47. This produces the negative-going ramp waveform, which may be seen at test point L. The ramp continues its downward slope until sufficient bias is built up to cause Q9 to conduct and restore the ramp level to the reference point and cause Q9 and Q10 to saturate. A positive pulse appears at test point J as the ramp voltage is restored to the ground level. This pulse, differentiated, is fed to Pin 7 of A3 to reset A3. The ramp length is varied in four ranges by the action of S2, which adds paralleled capacitance to cause the variation, and by S5, which changes the resistance according to the order of the harmonic analyzed.

The result of the above action results in positive square pulses developed at test point K, with frequency determined by the difference frequency; the amplitude is determined by the logic levels and the length is determined by the frequency range and the order of the harmonic under analysis.

Q12 and Q13 are used as a pulse amplifier. Q11 acts as a current source for Q12. The amplifier output consists of inverted, fixed-width pulses at the difference frequency, switching between +1 volt and +20 volts approximately. These pulses are filtered by C10 and R55 to become a varying source of positive dc at Pin 14, for application to the AFC control card 6132.

4-12 AFC CIRCUITS (CARD 6132)

This card is located at the left side of the rear section of range switch S2. The AFC circuitry accepts the varying positive voltage levels from terminal 14 of frequency comparator 6133 and converts the signals to varying quantities of capacitance and resistance to control the local oscillator frequency. The card also provides mounting space for relay K1, which is operated by the FUNCTION SWITCH to select local oscillator bridge components for second or third harmonic operation.

Input control level enters at terminal M. A signal near +1 volt at this point represents a high frequency difference, a signal near +20 volts indicates a small difference, as determined by the frequency comparator. The input signal splits in two branches: one to FETs Q1 - Q2, the other to Q3.

FETs Q1 and Q2 are reverse biased to act as capacitors. As the applied voltage through R1 and R2 changes, their gate-to-channel capacitance varies accordingly. The changes in

capacitance are applied to related sections of the local oscillator tuning capacitors in all frequency ranges through coupling capacitors C1 and C2. The capacitor action is quite effective in maintaining the correct offset frequencies on the first three test ranges from 100Hz to 100kHz for low-pass filters used for those ranges.

When tests are made in the high range of 100kHz to 1MHz, additional frequency control is needed at the low end of the range. The additional control is provided by the action of FETs Q4 and Q5, operating in this case as variable resistors. Note that their effect is introduced into the oscillator frequency control circuits at switch position 5 of S2 in the two harmonic generating circuits. Both FETs are driven by transistor Q3.

RANGE SWITCH S2

The functional connection of the range switch and its relation to AFC card 6132 is shown in Figure 6-8. Assemblies are mounted close together to control unwanted effects. The frequency-determining resistors and capacitors are mounted directly on the switch and on the AFC card.

4-13 POWER SUPPLY (CARD 1K01)

The Model 6100 has internal power supplies that convert 115/230 V ac $\pm 10\%$ line power (48-64Hz) to +24 volts dc and -24 volts dc. The power supply regulators have good line and load voltage regulation: Line regulation is about ± 1 millivolt over a $\pm 10\%$ line voltage variation, and load regulation is about 2 millivolts. Noise and 120Hz ripple on all supplies should be less than about 400 microvolts peak-to-peak.

Refer to Figure 6-11. For positive dc, the output of power transformed T1 is full-wave rectified by CR7 and CR10 and filtered by C3. For negative dc, the transformer output is rectified by CR8 and CR9 and filtered by C4. C9 and C10 suppress high-frequency transients from the power line.

The -24 volt supply is regulated by power transistor Q2* which is controlled by emitter-follower Q7. Q7 is part of a negative feedback circuit that amplifies output voltage variations and feeds them back to the regulator transistor Q2* to compensate for the original voltage variation.

The amplifier feedback circuit monitors the voltage at the center arm of R33, which is part of a voltage divider from the -24 volt bus to ground. A differential amplifier circuit Q9 and Q11 compares this voltage to the voltage across a Zener diode reference. Any difference between the two voltages is amplified and then amplified again by another differential amplifier circuit (Q10 and Q12). Transistor Q8 is a current source that acts as a high-impedance collector load for Q10. The signal at the collector of Q10 controls Q7, which in turn controls the regulator transistor Q2* to compensate for output voltage variations. Potentiometer R33 adjusts the -24V output.

(*Q2 is on the chassis, part number 48:22:2032.)

With two exceptions, the positive and negative regulators have identical circuits. One exception is, of course, voltage polarity, which in turn requires complementary transistors. The other exception is the voltage references for the differential amplifier (Q3 and Q6).

The positive regulator is referred to the -24 volt supply by the voltage divider R15, R16, and R17, which is connected from the +24 volt remote sense line to the -24 volt bus. The other voltage reference is the ground sense line, which is connected through R9 to the base of Q3. If the +24 volt sense line voltage changes, the voltage at the base of Q6 will change also, and the feedback circuit will compensate for the original voltage change. Similarly, if the -24 volt supply should drop out of regulation (e.g., short-circuit or if F2 blows), then the +24 volt regulator will drop out also. The potentiometer R16 adjusts the +24 volt supply.

SECTION V

MAINTENANCE AND CALIBRATION PROCEDURES

5-1 INTRODUCTION

This section contains instructions for conducting calibration and performance checks for the Model 6100 Test Set. The instructions include abbreviated preventive maintenance information, the necessary disassembly instructions, and calibration and performance test procedures.

5-2 PREVENTIVE MAINTENANCE

Preventive maintenance should be performed at regular intervals in order to minimize equipment failure and malfunctions.

VISUAL INSPECTION

Periodically remove the equipment covers from the housing and inspect the components for cracks or signs of looseness. Check connectors and cables for damage or corrosion.

CLEANING

Remove loose dust, dirt, or lint from the interior of the unit with a vacuum cleaner, a soft dry brush, or a clean, lint-free cloth.

5-3 CALIBRATION AND PERFORMANCE CHECKS

The calibration and performance checks described in the following paragraphs are presented in test form, on a step-by-step basis. Because of the interrelated nature of the functional circuits contained in the test set, the procedures should be performed in stated sequence to produce maximum reliability and effectiveness in the use of the instrument. Calibration and performance checks are conducted simultaneously. If difficulty is experienced in adjusting a voltage, circuit, or other component, the instructions provide clues to locate a faulty component in order to complete the adjustment. If a definite malfunction exists in the test set, trouble can be traced to the exact circuit or component by voltage and resistance measurement, substitution, and other techniques. Maintenance personnel may then check the parts and make substitution with new parts by consulting applicable schematic diagrams in Section VI of this manual.

5-4 TEST EQUIPMENT

The following items of test equipment, or their equivalents, are required for the calibration and performance checks of the Model 6100 Test Set. Table 5-1 lists the equipment by functional name, required specifications, and suggested commercial model.

Table 5-1 is found on page 5-2.

5-5 POWER SUPPLIES

To measure and adjust the dc voltages of the regulated power supplies, proceed as follows:

1. Place POWER switch S6 on the front panel in the ON position and allow 20 to 30 minutes for thermal stabilization.
2. Connect the DVM from J5-1 (-24V bus) to chassis. Adjust R33 on card 1K01 (-24V pot) for indication of $-24V \pm 50mV$.
3. Connect the DVM from J5-15 (+24V bus) to chassis and adjust R16 on card 1K01 (+24V pot) for indication of $+24V \pm 50mV$.
4. Measure voltage at the load end of 7-watt resistor R53 on card 6133 for normal indication of between +3.5 and +4V dc.
5. Measure voltage at J2-7 on card 6134 for normal indication of $+11V \pm 0.5V$ dc.
6. Measure voltage at J2-8 on card 6134 for normal indication of $-5.3V \pm 0.25V$ dc.
7. Rotate the OSC LEVEL control to the maximum CCW position. Measure voltage across R23 on card 6137 (180 ohm, 3W, ww) for normal indication of $7.2V$ dc $\pm 10\%$. If unable to obtain a correct reading, replace R21 on the same card with the resistor in the nominal range of 43-68 ohms (1/2W, 5%).
8. Measure dc voltage at OSC OUTPUT J6 on the front panel. Adjust Z5, R15, on card 6137 for $0V \pm 10mV$.

SECTION V

5-6 TEST OSCILLATOR SECTION

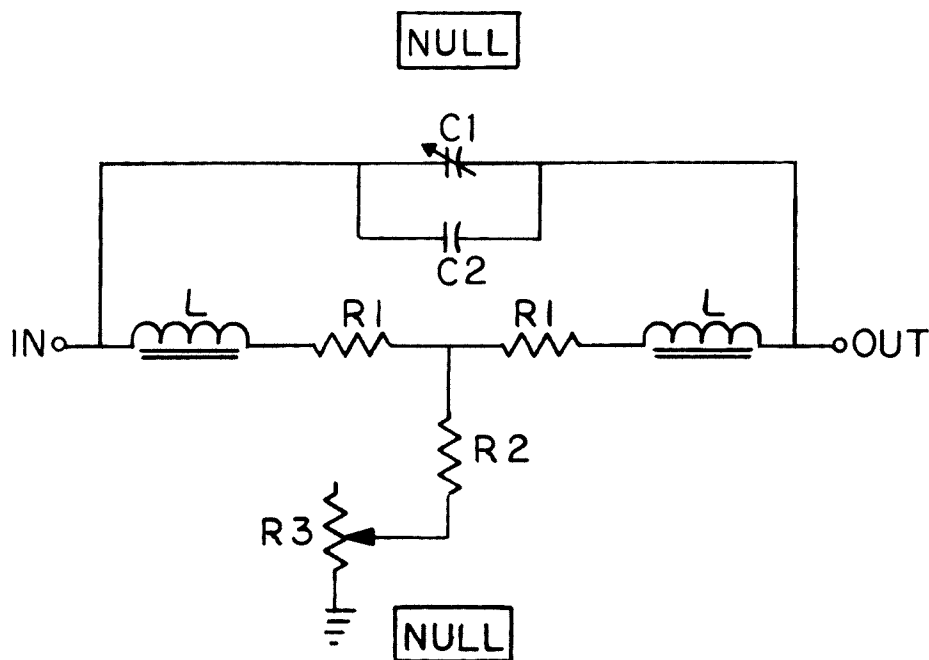
Perform calibration measurements and adjustments as follows:

1. Loosen the detent collar set screw on tuning dial shaft.
2. Attach the ac voltmeter test lead to Pin E on card 6135. Attach the dc voltmeter test lead to Pin D. Attach the frequency counter to Pin F. Set OSC RANGE switch S2 on the front panel to X1K and tune to the 1kHz reading on the frequency counter. Loosen the tuning dial, set it to agree with the 1 indication, and retighten it.
3. Adjust LEV output level control R46 on card 6135 for indication of 1.2V rms.
4. Measure and note the dc voltage at Pin D for nominal -2.5 to -4.5V dc. Rotate the tuning dial to 10 and adjust C1 and C6 trimmer capacitors on range switch S2 to indicate 10kHz on the frequency counter and the same voltage as previously indicated on the dc voltmeter. Turn the C1 adjustment screw CW to decrease frequency and increase negative voltage indication. Turn the C6 adjustment screw CW to decrease frequency and decrease the negative voltage.
5. Rotate the tuning dial to the extreme high frequency end (CCW) and observe the frequency meter for maximum frequency position. Rotate the dial slightly CW from this position and tighten the detent collar set screw for the dial to stop at this position.
6. Attach the frequency counter to OSC OUTPUT J6 on the

TABLE 5-1

RECOMMENDED TEST EQUIPMENT

Instrument Type	Required Characteristics	Recommended Instruments
DC Voltmeter	$\pm 1\%$ accuracy from 100mV to 100V input Impedance 10M Ω	HP 3430A
AC Voltmeter	1mV to 30V - Input 10M Ω , <25pF accuracy $\pm 1\%$, 40Hz to 2MHz; $\pm 5\%$ 10Hz to 10MHz	HP 400EL
AC Voltmeter	1mV to 3V - Input 100K, <10pF accuracy $\pm 3\%$, 100kHz to 50MHz	HP 3406A
Electronic Counter	10Hz to 10MHz - Input 1M Ω , 30pF Time base accuracy 0.01%	HP 5221B
Oscilloscope	DC to 150MHz - Dual channel 5mV to 10V/div - 0.05 μ s to 20ms/div Input 10M Ω , 10pF	Tektronix 454 with P6047 probes
Sinewave Oscillator	10Hz to 10MHz - Flatness $\pm 0.25\%$ at 3.16V rms output into 50 Ω . THD <1% to 2MHz; <4% to 10MHz	HP 652A
Sinewave Oscillator Synchronizable	200Hz to 2MHz - Up to 20V rms output. THD <2% - Sync. sensitivity $\pm 3\%$ Vrms	General Radio 1310A
Distortion Analyzer	10Hz to 600kHz - 0.1% THD full-scale. Accuracy $\pm 3\%$ - Input 1M Ω , <70pF.	HP 333A
Modulator, AM	50kHz center frequency - up to 50% amplitude modulation - 2V out from 600 Ω .	MICOM 9100A
Low-pass Filter	Adj. 100Hz to 1MHz - Rolloff 24dB per octave - Input 100k Ω , 50pF	KROHN-HITE 3202
Step Attenuator	600 Ω - 110 dB in 1dB steps - 1/4W	HP 350A
Feedthrough Terminator	50 $\Omega \pm 1\%$ to 10MHz	Texscan FT-50
Notch Filter	1MHz - 5MHz - 10MHz, 600 Ω	See Figure 5-1



FREQ.	L	C1	C2	R1	R2	R3	
1MHz	68 μ hy	100 pF MAX.	150 pF	36 Ω	1500 Ω	1K	
2MHz	15 μ hy			18 Ω	510 Ω	500 Ω	
5MHz	2.2 μ hy			4.7 Ω	200 Ω	250 Ω	
10MHz	0.68 μ hy	↓	↓	3.9 Ω	150 Ω	100 Ω	

- NOTES:
1. All inductors are Nytronics, Inc., Super Wee-Ductor Series.
 2. Variable capacitor is Hammarlund Type HF-100.
 3. Filter must be mounted in shielded box.

FIGURE 5 - 1 NOTCH FILTER

SECTION V

front panel. Disconnect the ac voltmeter from Pin E on card 6135. Rotate the OSC LEVEL control knob to a mid-range position, switch the OSC RANGE selector to the X1M position, and adjust to 1MHz. Measure and note the dc voltage at Pin D on card 6135. The voltage should be nominally in the range from -2.5 to -4V dc.

7. Rotate the frequency dial to 10 and adjust C3 and C9 trimmer capacitors on range switch S2 to indicate 10MHz on the frequency counter and dc voltage on Pin D of approximately the same value indicated in step 4. Rotate screw C3 CW to increase the frequency and negative voltage; rotate C9 CW to decrease frequency and negative voltage. Check for squegging or signal dropout when rotating the dial throughout its entire range. (An oscilloscope connected in parallel with the counter will provide effective observation.) If squegging or dropout occurs, rotate the dial to 10 and optimize C3 and C9 for the same frequency but different dc voltage. Repeat the optimizing adjustment until no further trouble is evident at any position of the frequency dial.

8. Disconnect the frequency counter. Connect the ac voltmeter to OSC OUTPUT J6 through a 50-ohm feedthrough termination. Place the OSC RANGE selector switch to the X1K position and rotate the FREQUENCY dial to 1. Adjust the OSC LEVEL control for 2Vrms indication. Place the OSC RANGE switch in the X1M position and the FREQUENCY dial at 10; adjust C2 on card 6137 for 2Vrms indication.

5-7 AC VOLTMETER SECTION

1. Set front panel METER FUNCTION switch S5 to VM INPUT; set LEVEL selector switch S4 to the 10mV position. Feed INPUT jack J7 with a 10mV signal at 1kHz from the HP-652A signal generator through a 50-ohm feedthrough termination. Connect the ac voltmeter at METER AMP OUT rear panel jack J9. Adjust GS (gain set) pot R33 on card 6136 for a 1Vrms indication.

2. On card 6136, adjust the VFS R61 control (voltmeter full scale) for full-scale indication on M1 front panel meter.

3. Set the external generator to 10MHz at 10mV; adjust capacitor C3 on card 6136 (HF1) for a 1V indication on the ac voltmeter. Disconnect the ac voltmeter from J9 at the rear panel.

4. Adjust the HF2 trimmer capacitor C30 on card 6136 for full-scale indication on M1 meter panel.

5. Set LEVEL switch S4 to the 100mV position. With the generator at 1MHz, 100mV, adjust trimmer capacitor C2 on card 6154 in the attenuator/preamplifier box assembly to full-scale meter indication.

6. Set LEVEL selector switch S4 to the 1V position. With the generator set at 1MHz, level at 1V, adjust trimmer C3 on card 6154 to full-scale meter indication.

7. With the generator still at 1MHz, with output reduced to 3.16mV, set LEVEL switch S4 to the 10mV position and ob-

serve indication. With the generator at 1MHz, 3.16V, set LEVEL switch S4 to 10V position and adjust C4 on card 6154 to duplicate the same indication.

5-8 WAVE ANALYZER SECTION

Proceed with wave analyzer calibration and adjustments as follows:

1. Place the panel METER FUNCTION switch S5 in the 3rd position; set LEVEL selector switch S4 to the 1V position. With the external generator, feed a 1V, 1kHz signal into INPUT jack J7. Attach the ac voltmeter probe to test point TP-1 on card 6134. Adjust LEV pot R83 to indicate 60mV. Disconnect the voltmeter from the test point.

2. On card 6134, set B and A rejection pots R19 and R20 to mid-range positions. Temporarily remove the lead from Pin E on card 6135-1. Set OSC RANGE selector switch S2 to the X10K position. Using the input signal as described in step 1, connect channel 1 input of the oscilloscope to display the input signal. Set oscilloscope controls to trigger on channel 1 only, and sweep on alternate mode. Connect the channel 2 input of the oscilloscope to METER AMP OUT J9 on the rear panel. On card 6134, adjust SB (Signal Balance) pot R43 for minimum indication at rear panel J9 (this signal has mainly second harmonic content). Disconnect the signal generator.

3. Connect the output of the generator to the coaxial cable disconnected from Pin E on card 6135-1 in step 2, in parallel with the oscilloscope's No. 1 channel. Set the generator to deliver 2V at 2kHz. With scope channel 2 still connected to J9, set the OSC RANGE switch to the X100K position. Adjust the CB (Carrier Balance) R36 pot on card 6134 for minimum output observed at J9. Disconnect the generator from the coaxial lead and restore the leads to Pin E on card 6135-1.

4. Set the OSC RANGE switch to the X1K position, with the FREQUENCY dial at 1. Connect the dc voltmeter lead to Pin E to measure card 6135-1 output level. Adjust LEV (Level) control R47 to indicate 2Vrms. Disconnect the ac voltmeter and the oscilloscope from their terminals.

5. Use a 50-ohm feedthrough termination to connect the front panel OSC OUTPUT to INPUT. Set the OSC RANGE selector at X1K, the FREQUENCY dial at 1, and the LEVEL switch at 1V. Set METER FUNCTION switch S5 at the VM INPUT position. Adjust the OSC LEVEL control to indicate 1Vrms on panel meter M1.

6. Remove card 6133 from its connector and check for ohmmeter indication of 500 ohms $\pm 10\%$ between Pins 2 and 9 of connector J1 with the FREQUENCY dial at 10. If the indication is not correct, physically adjust the body of potentiometer R3 at the end of the tuning capacitor shaft. Rotate the body until proper indication is observed and cement the body at that position in its grommet mounting. Remove ohmmeter leads and replace the circuit card in the connector.

7. At card 6134, connect the channel 1 probe to J1-12 or TP-L. The negative ramp waveform observed at this point

is used to trigger the chopped sweep mode of the oscilloscope. Connect the second scope channel input to J1-14 or TP-M. Use dc coupling and adjust the second display zero toward the bottom of the screen. Set the OSC RANGE switch at X100, the tuning dial at 10, and the METER FUNCTION switch at 3% 2nd position. Adjust trimmer C25 on range switch S2 for a +10V indication on the second channel.

8. With the oscilloscope still connected, rotate the tuning dial slowly through the range connected. Observe the period of the ramp and compare it with normal limits stated in Table 1 on the following pages of this procedure. If the observed period is too short, turn the trimmer adjustment screw clockwise to lengthen and vice versa, and set the ramp period to agree with data given in the table for this range.

9. With the OSC RANGE switch at X1K and the dial at 10, adjust C27 trimmer capacitor on the range switch to provide +10V indication on channel 2.

10. Repeat step 8 to equalize adjustments made in step 9; proceed to step 11.

11. Set the OSC RANGE selector at X10K, repeat the operations of step 8. Compromise the adjustment of C27 trimmer capacitor to provide correct tracking indications for the X1K and X10K ranges.

12. Rotate the OSC RANGE switch to X100; leave the FREQUENCY dial at 10; set the METER FUNCTION switch to 3% 3rd position. Adjust the C19 trimmer capacitor of the S2 range switch assembly to provide +10V indication on scope channel 2.

13. Again, repeat step 8; proceed to step 14.

14. With the OSC RANGE switch at X1K and the dial at 10, adjust C21 trimmer on the range switch assembly to provide +10V indication on scope channel 2.

15. Repeat step 8 before proceeding with step 16.

16. Rotate the OSC RANGE switch to X10K and repeat step 8. Again, compromise adjustment of C21 trimmer for correct tracking in the X1K and X10K ranges.

17. With the OSC RANGE switch at X100K, the dial at 1, and the METER FUNCTION switch at 3% 2nd position, connect the dc meter to Pin D on card 6135 and observe the negative voltage. Note the voltage for later reference.

18. Rotate the FREQUENCY dial to 10; adjust C29 and C30 trimmers to indicate +10 volts on channel 2, and the same negative voltage displayed on voltmeter as noted in step 17. Clockwise adjustment of C29 will produce increased indications on channel 2 and the negative voltage displayed on the voltmeter. Adjustment of C30 will increase channel 2 voltage but will decrease the negative meter voltage indication.

19. Rotate the FREQUENCY dial slowly throughly the entire range and observe that the waveform is in conformity with

limits stated in Table 1. If the ramp waveform is not correct, adjust trimmers C29 and C30 clockwise to lengthen the period or counterclockwise to shorten the period.

20. Repeat step 17 with the METER FUNCTION switch at 3% 3rd position.

21. Repeat step 18, using C23 instead of C29 and C24 instead of C30.

22. Repeat step 19 for compromise adjustments and proceed with step 23.

TABLE 1

Pulse repetition period for negative ramp waveform at J1-12.

S5 METER FUNCTION Position		S2 OSC RANGE Position			
		X100	X1K	X10K	X100K
3% 2nd	Nominal	200ms	20ms	2ms	1ms
	Min-Max	130-400	13-40	1.3-4	0.7-2
3% 3rd	Nominal	300ms	30ms	3ms	1.5ms
	Min-Max	200-600	20-60	2-6	1-3

23. Disconnect the scope and dc voltmeter leads. Set the OSC RANGE switch to X10K and the tuning dial to 5 (50kHz indication). Set the METER FUNCTION switch to 3% 2nd. Couple card 6134 to its socket by means of the extender card. Feed a 50 kHz signal of 1 volt with 100 Hz amplitude modulation added to the carrier, with 50% modulation index to J7 input jack, in parallel with oscilloscope channel 1. Connect the number 2 channel input to MTR AMP OUT jack J9 on the rear panel. Use alternate sweep mode synchronized externally by the 100 Hz modulating signal. Adjust B and A pots R19 and R20 respectively on card 6134 for minimum output signal observed at J9. (If available, a 50kHz signal from a MICOM Model 9100 Modulator may be used as follows: Set MODULATION at AM; set CENTER FREQ at 50kHz; and, feeding the 100Hz from the signal generator at EXT INPUT, pass the signal from OUTPUT through a low-pass filter having a corner frequency of 50kHz, with 24dB per octave minimum rolloff).

24. Produce 1% 2nd harmonic distortion to the signal at J7 by mixing at the input the 1Vrms AM 50kHz signal with a 10mVrms 100kHz signal from an oscillator synchronized with the modulated signal. Readjust R19 and R20 on card 6134 if required, to produce envelope waveform symmetry at J9, with minimum variation indicated on M1 meter panel when changing the modulation factor from 50% to zero. (The indication change should not exceed 2%.) Disconnect the input signal from J7 and replace card 6134 in its receptacle.

25. Set the METER FUNCTION selector to 3% 3rd position. Connect OSC OUT J6 output to 50kHz, 24dB/oct low-pass filter input and to the synchronization input of the controllable signal generator. Connect the output of the 150kHz

SECTION V

generator to a 500-ohm attenuator box input for use as a separator. Connect the filter output, attenuator box output, and ac voltmeter in parallel to INPUT J7. Rotate the OSC LEVEL control R1 fully CCW; set the signal generator output near maximum. Adjust attenuator controls to provide approximately a 31.6mV indication on the ac voltmeter and make final adjustment to this value with the generator level control. Increase the OSC LEVEL control for an indication of 1V on the ac voltmeter. Synchronization may be verified by simultaneously displaying both the test oscillator and signal generator outputs in the added mode on the oscilloscope. Connect an additional ac voltmeter to J4-5 or TP-C on card 6136. Adjust R12 on card 6134 (MS) for indication of 5mVrms. Disconnect the ac voltmeter.

26. Adjust R21 DFS (distortion, full scale) on card 6136 for full scale indication, 3.16% on front panel meter M1.

SECTION VI

SCHEMATICS

6-1 COMPONENT LOCATIONS

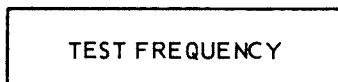
Figure 6-1 on page 6-2 shows the location of all cards, connectors, and controls in the package.

6-2 SCHEMATIC DIAGRAMS

This section contains the schematic diagrams necessary for maintenance and calibration of the Model 6100 Test Set. Each diagram illustrates the circuits on assemblies, connectors, and related components.

The following conventions are used on all drawings:

1. Components mounted on the card are enclosed with a dotted outline.
2. Front panel designations are enclosed within a box:



3. Component values marked ▲ are nominal, optimum values selected at factory, or may be omitted.

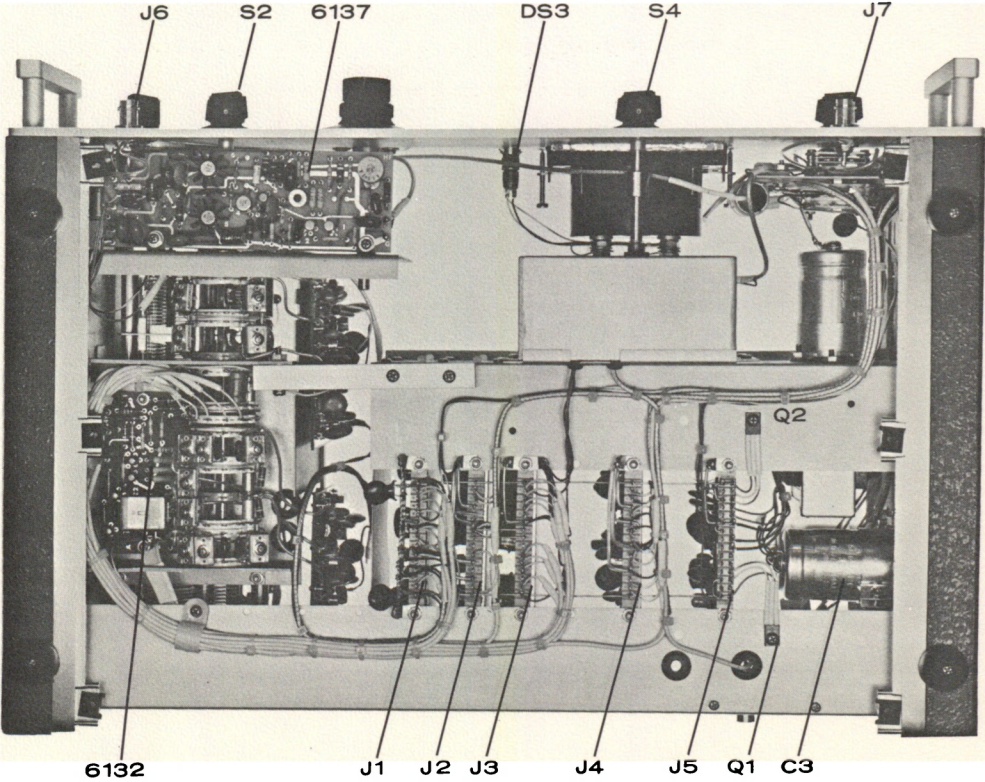
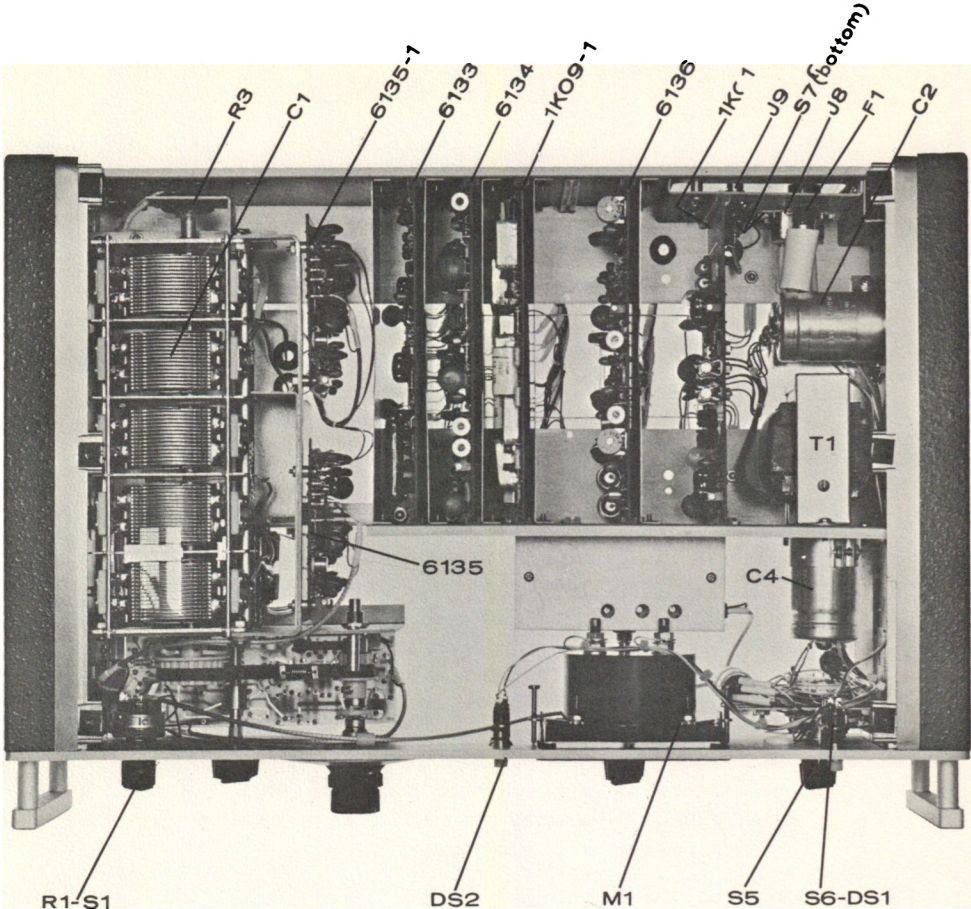
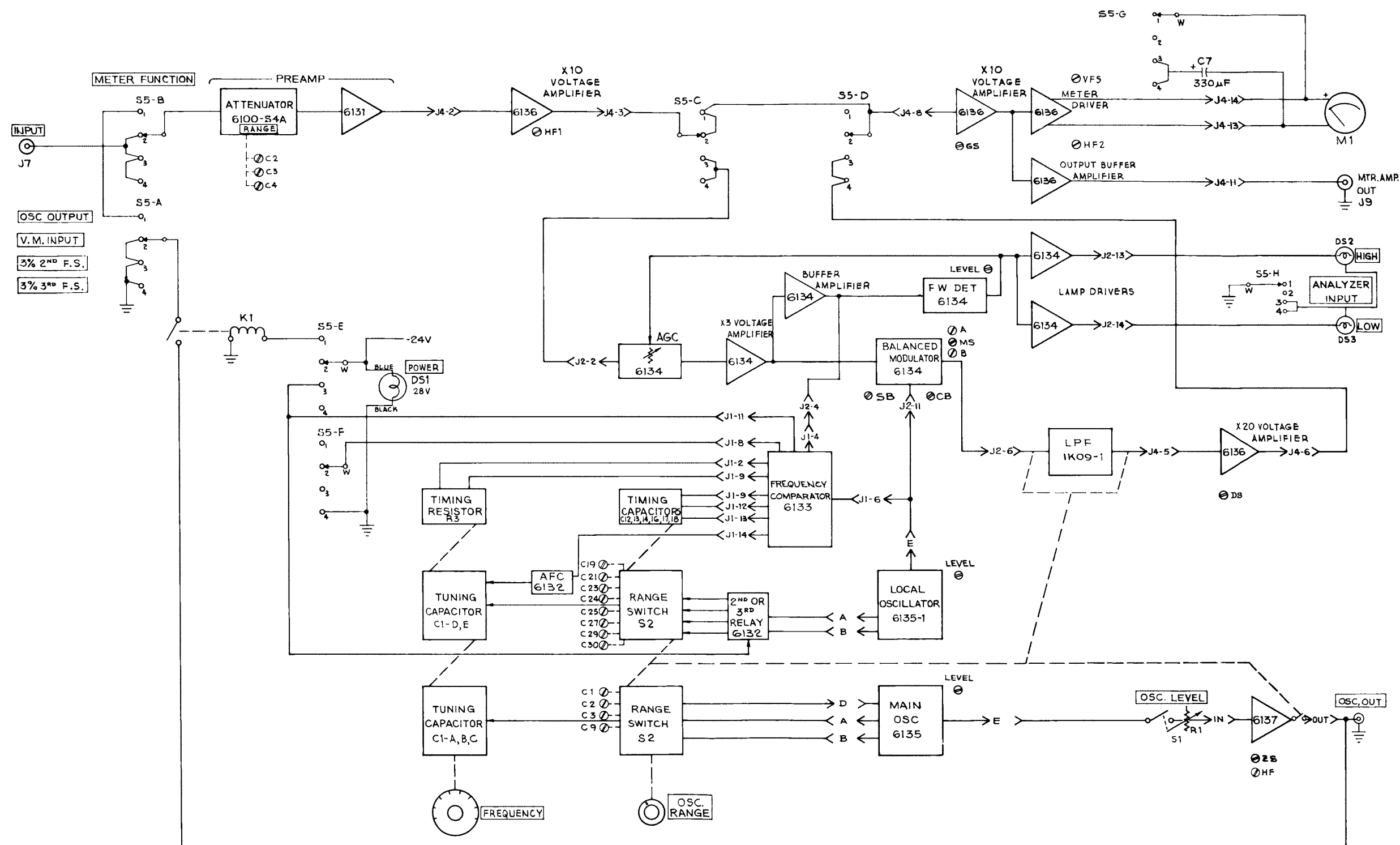


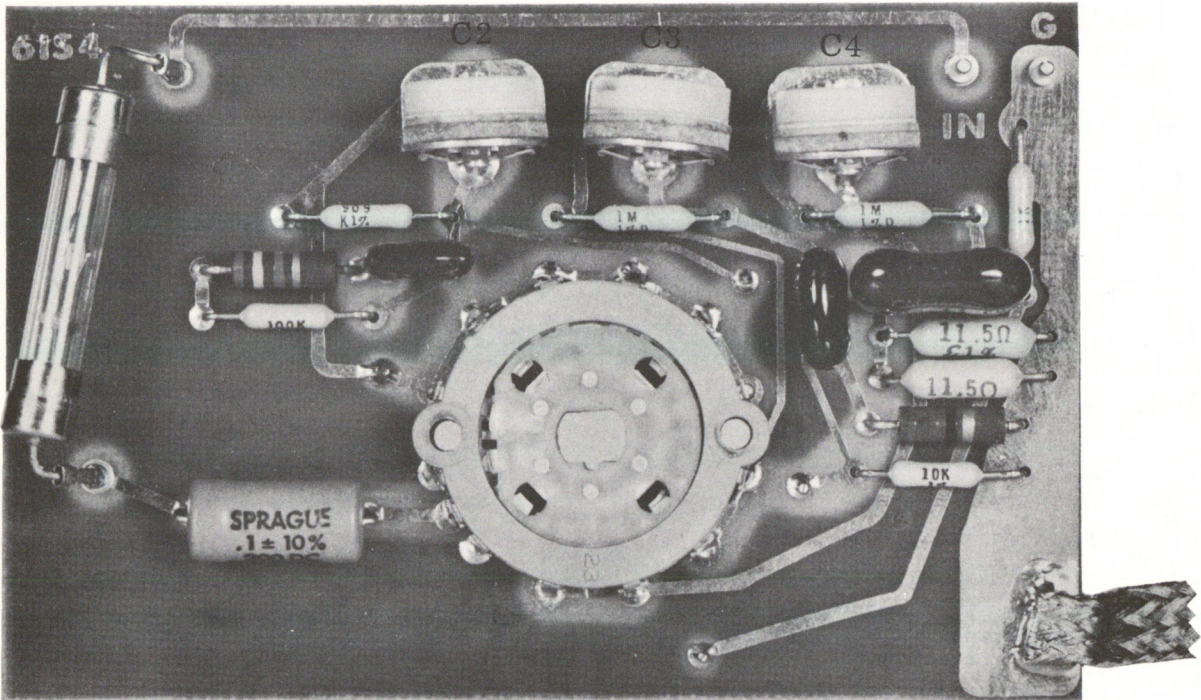
FIGURE 6 - 1 TOP AND BOTTOM INTERIOR VIEWS



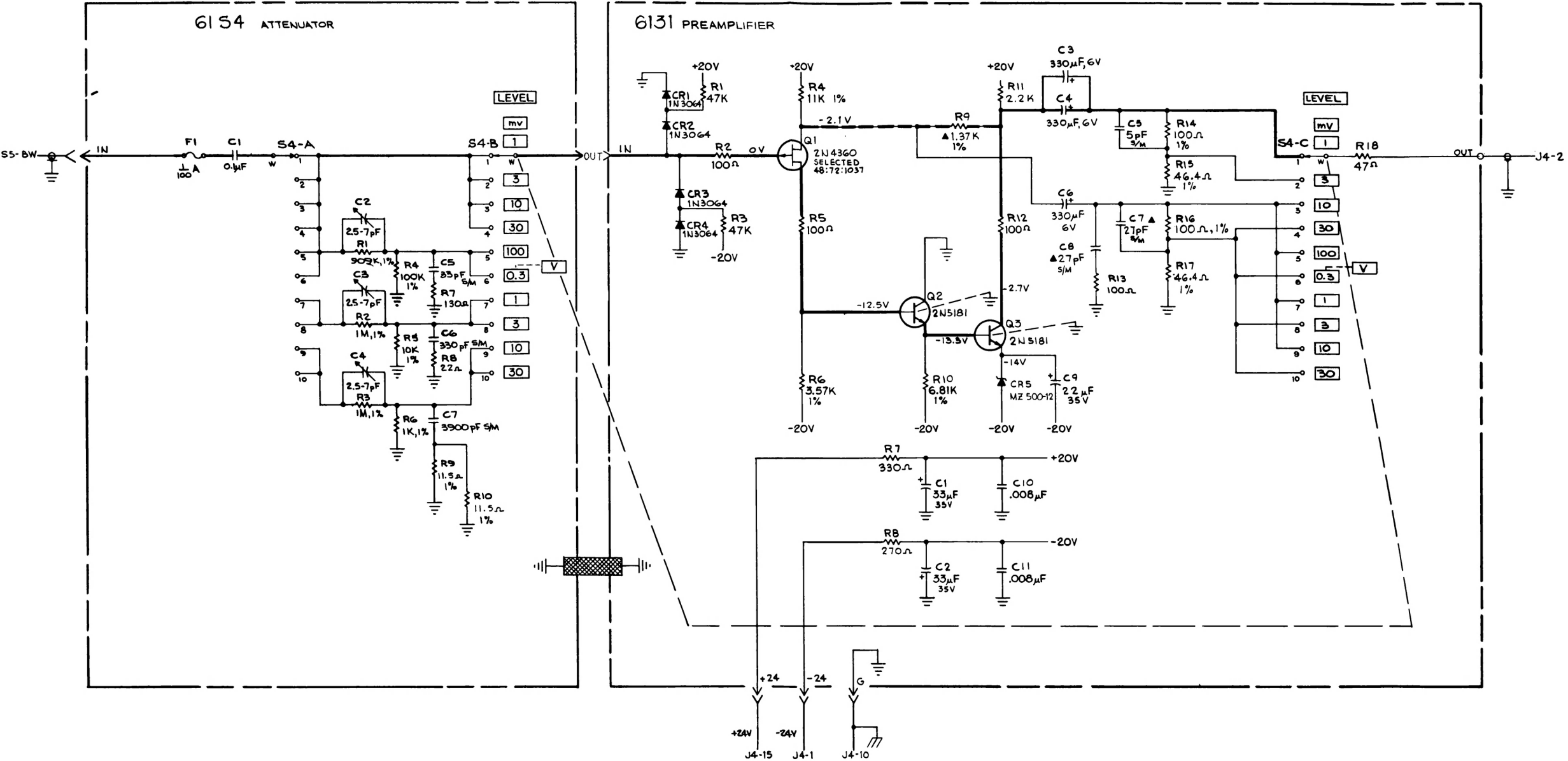
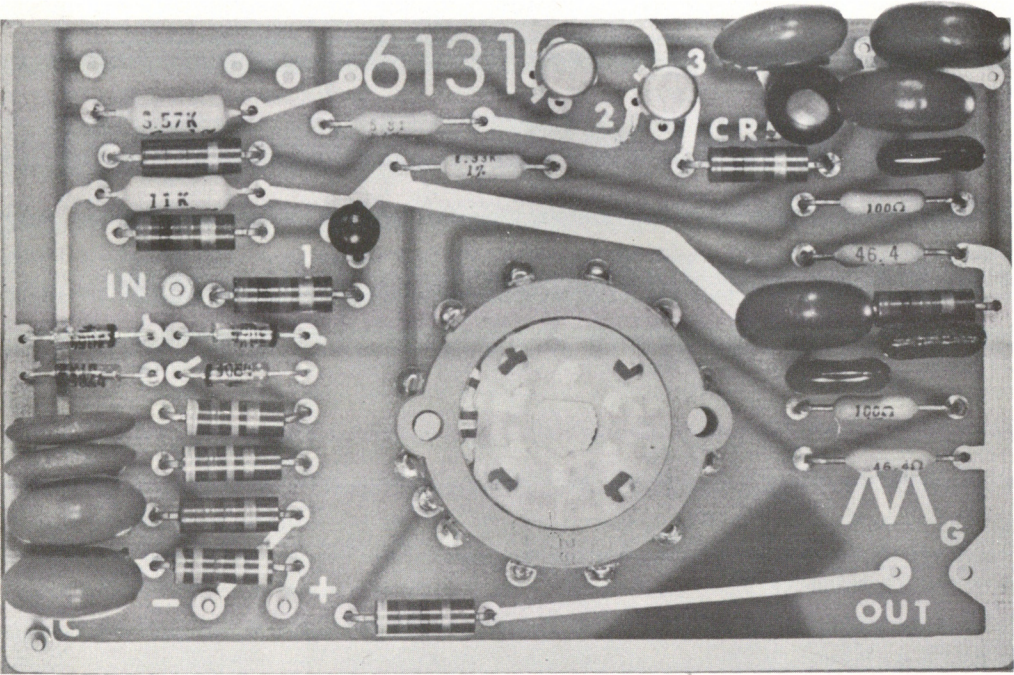
2. Ⓢ INDICATES INTERNAL ADJUSTMENTS.
1. [] INDICATES FRONT PANEL MARKING.
NOTES:

FIGURE 6 - 2

61S4



6131



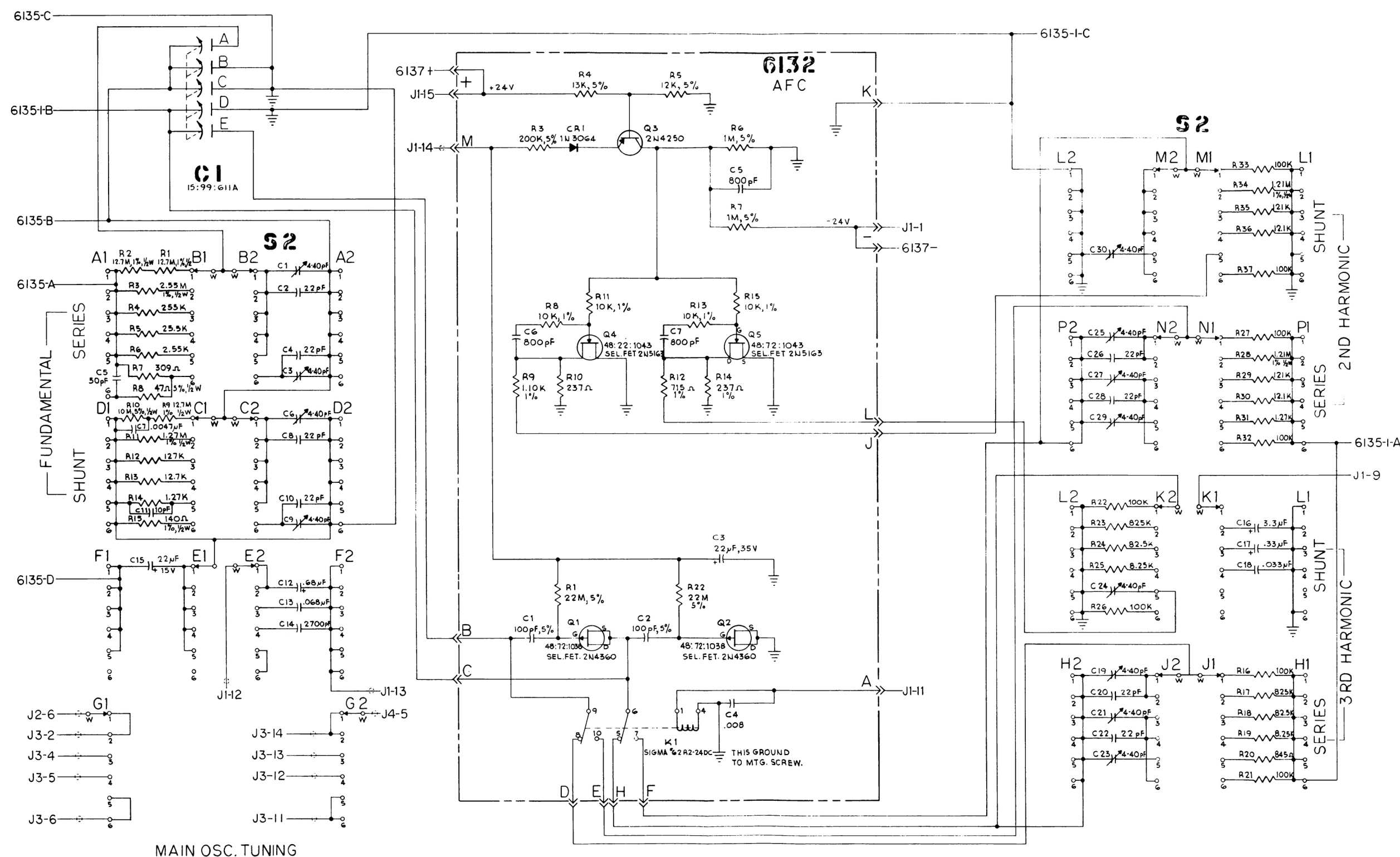
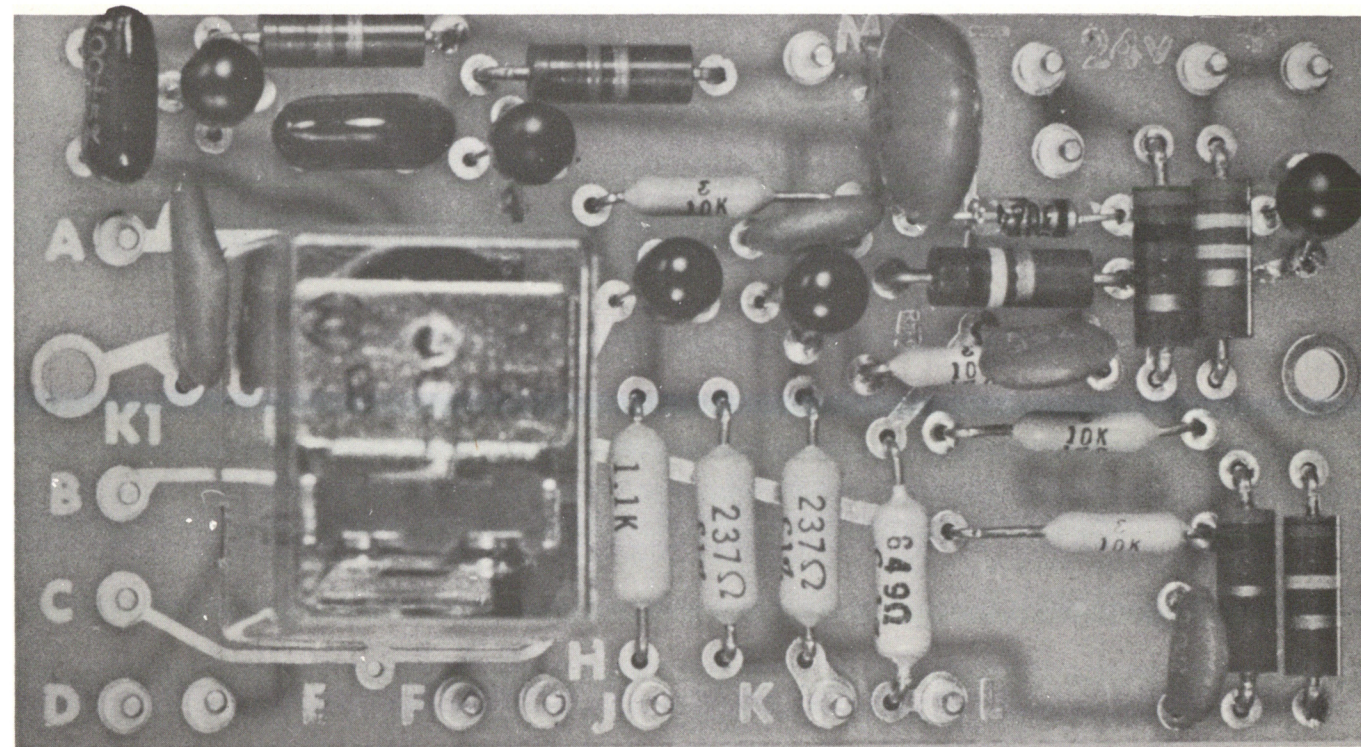
61S4	
REF. DES. CHART	
LAST NO. USED	NOT USED
C7	
F1	
R10	

6131	
REF. DES. CHART	
LAST NO. USED	NOT USED
C11	
CR5	
R18	
Q3	

7. Δ INDICATES NOMINAL VALUE. COMPONENT SELECTED AT CALIBRATION.
6. UNLESS NOTED, RESISTORS ARE 1/2 W, 5%.
5. ——— INDICATES FEEDBACK
4. ——— INDICATES SIGNAL FLOW.
3. ALL 1% RESISTORS ARE METAL FILM.
2. SM INDICATES SILVER MICA.
1. - - - - - INDICATES CIRCUIT CARD OUTLINE.
NOTES:

FIGURE 6 - 3
Cards 61S4 & 6131
PREAMPLIFIER
6 - 4

6132



2. 100K RESISTORS ARE $\pm 5\%$, $\frac{1}{2}W$, COMPOSITION.
1. RESISTORS ARE $\pm 1\%$, $\frac{1}{4}W$, METAL FILM.
NOTES - UNLESS OTHERWISE STATED:

FIGURE 6 - 4

Card 6132

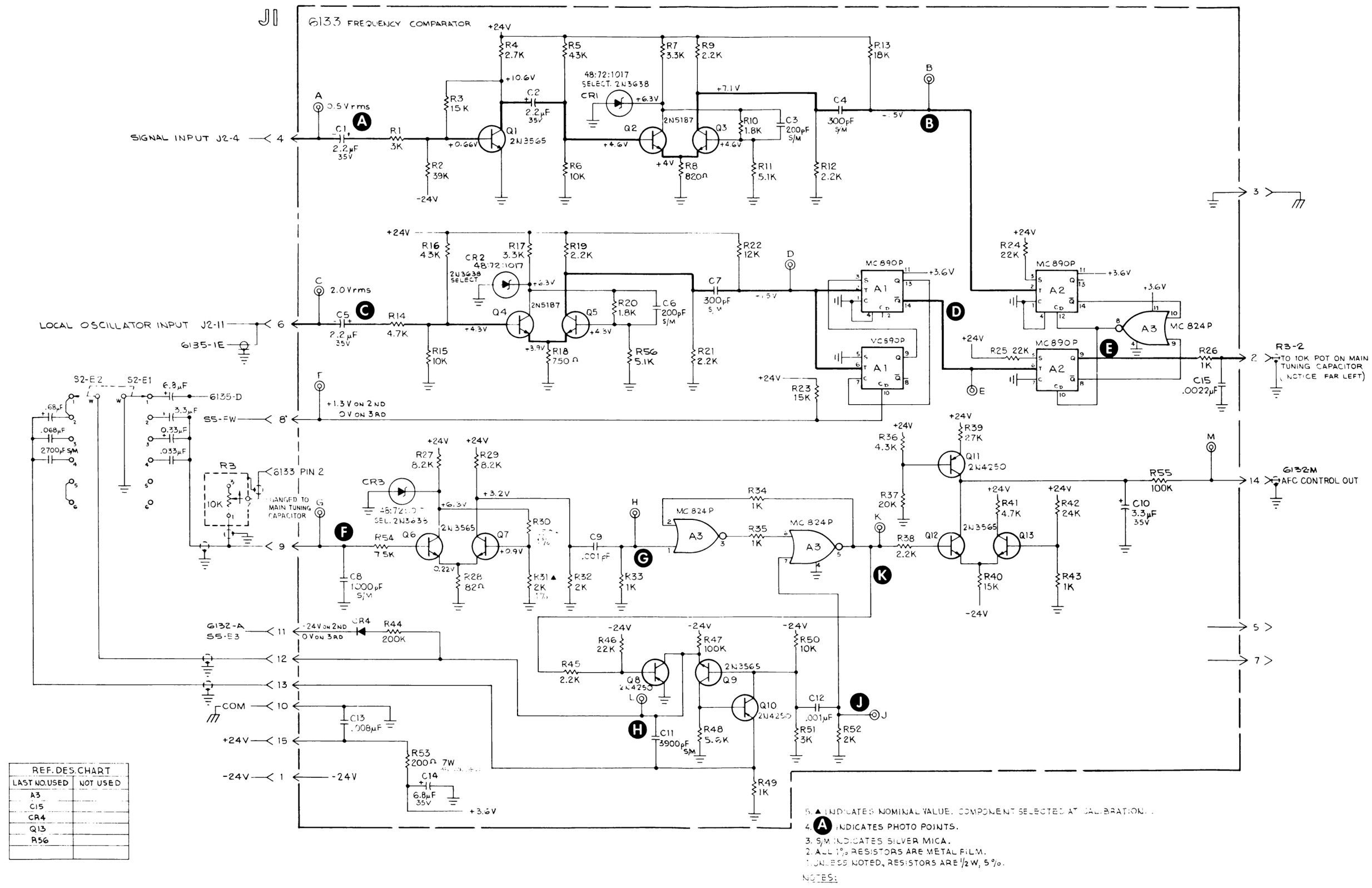
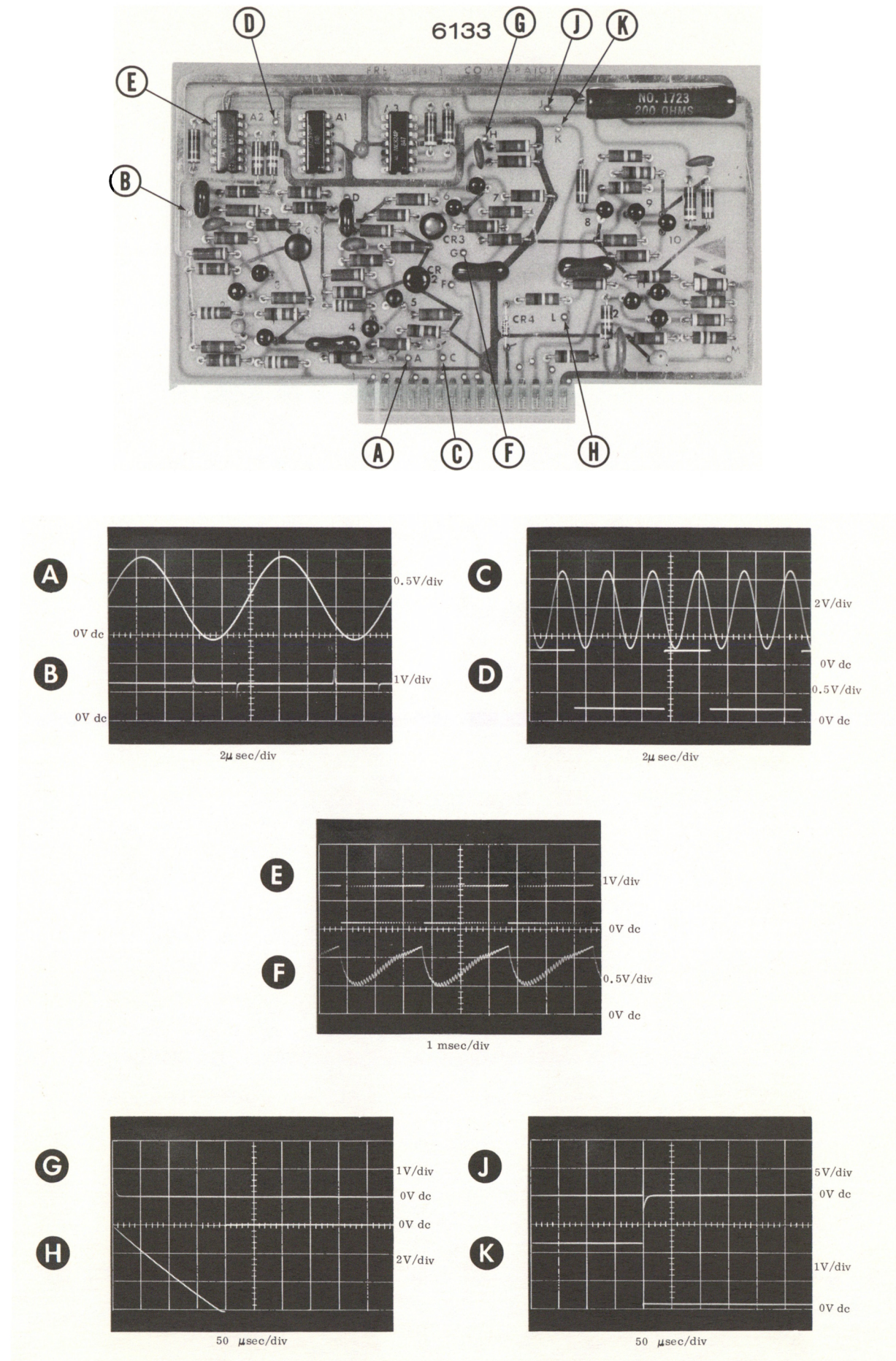
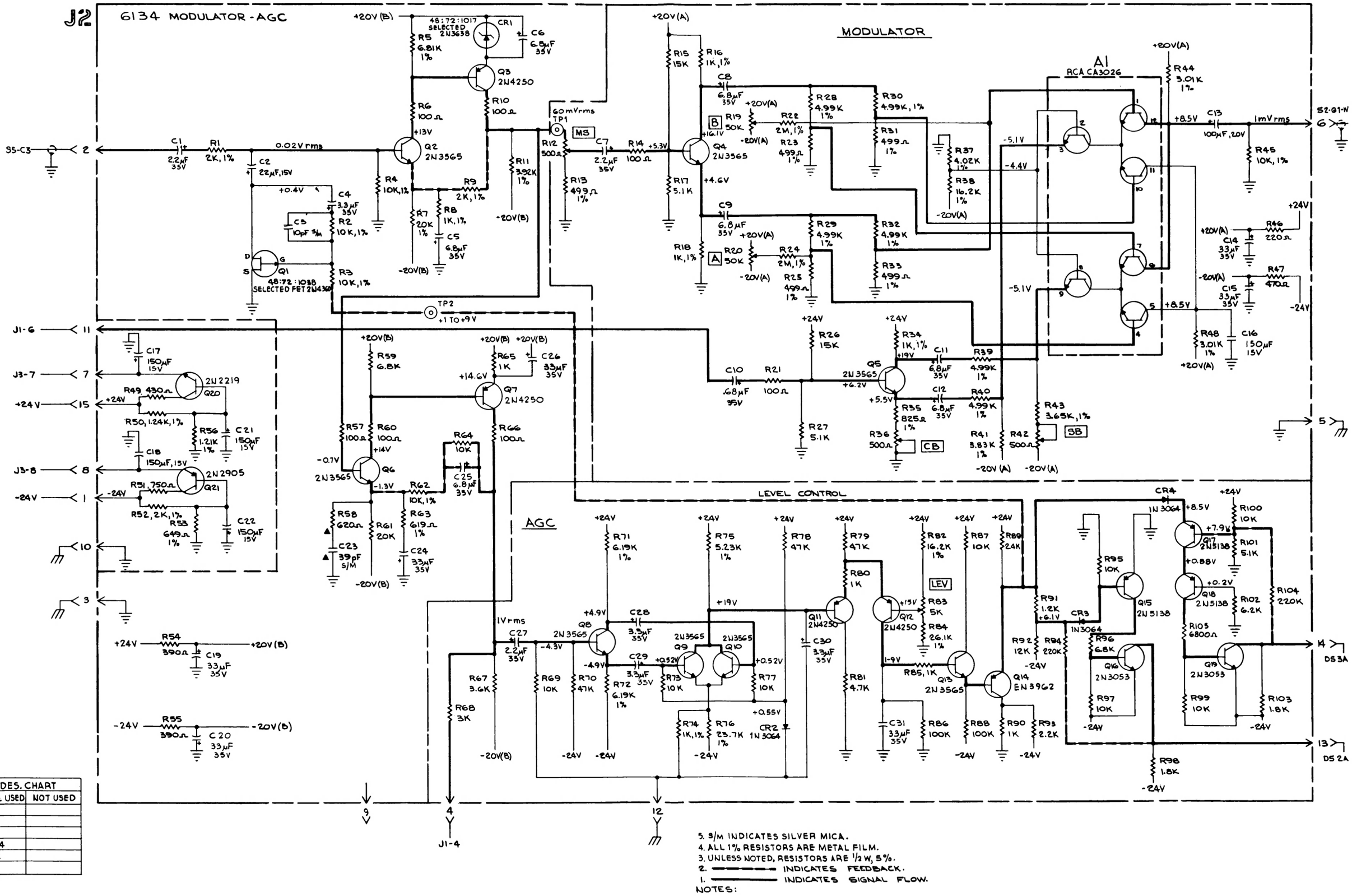
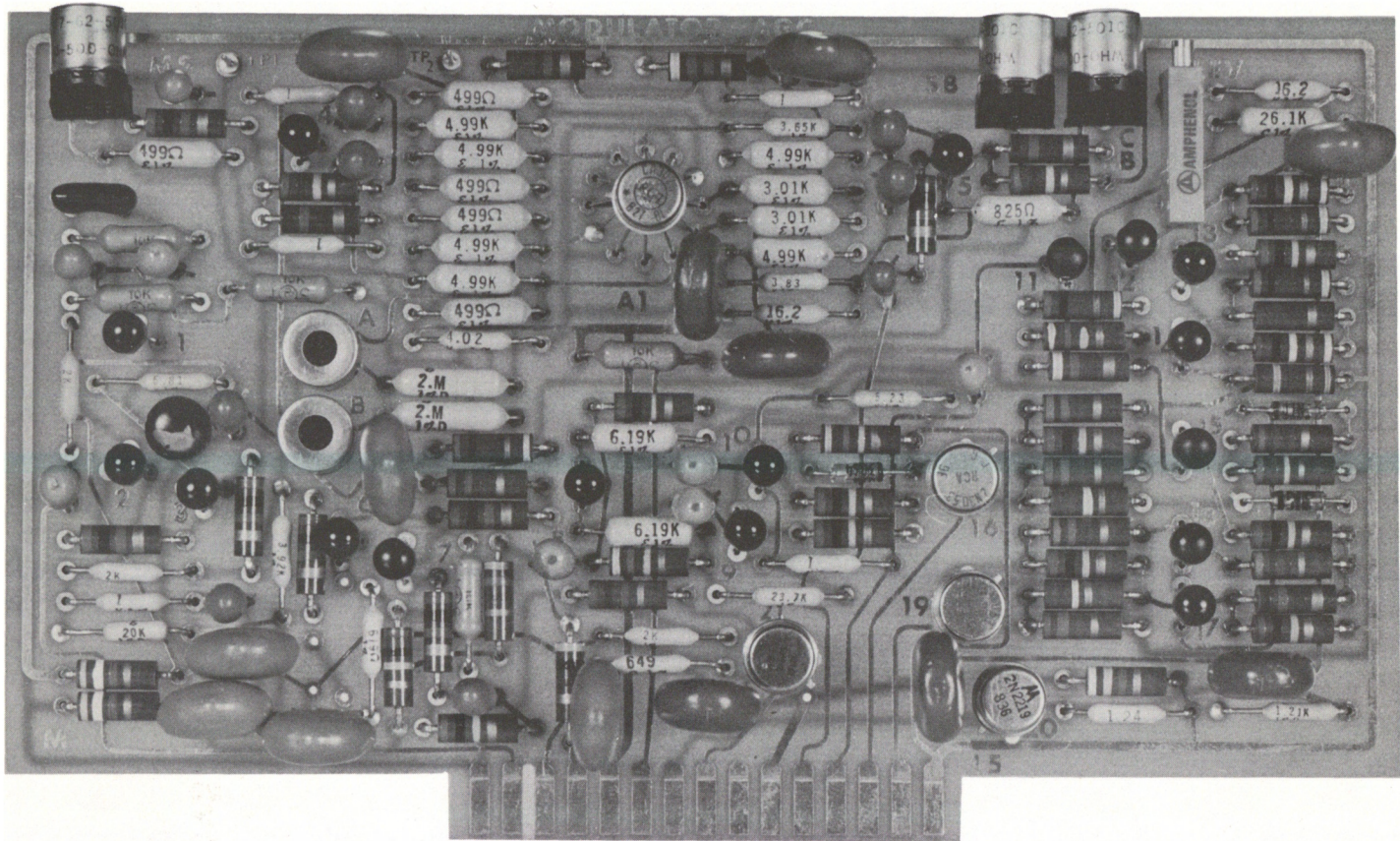


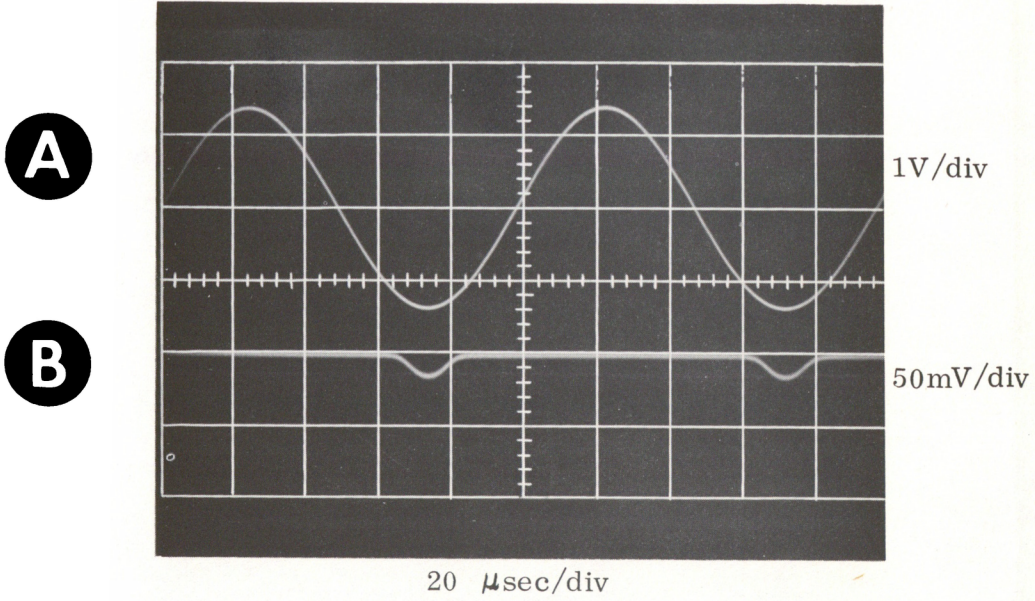
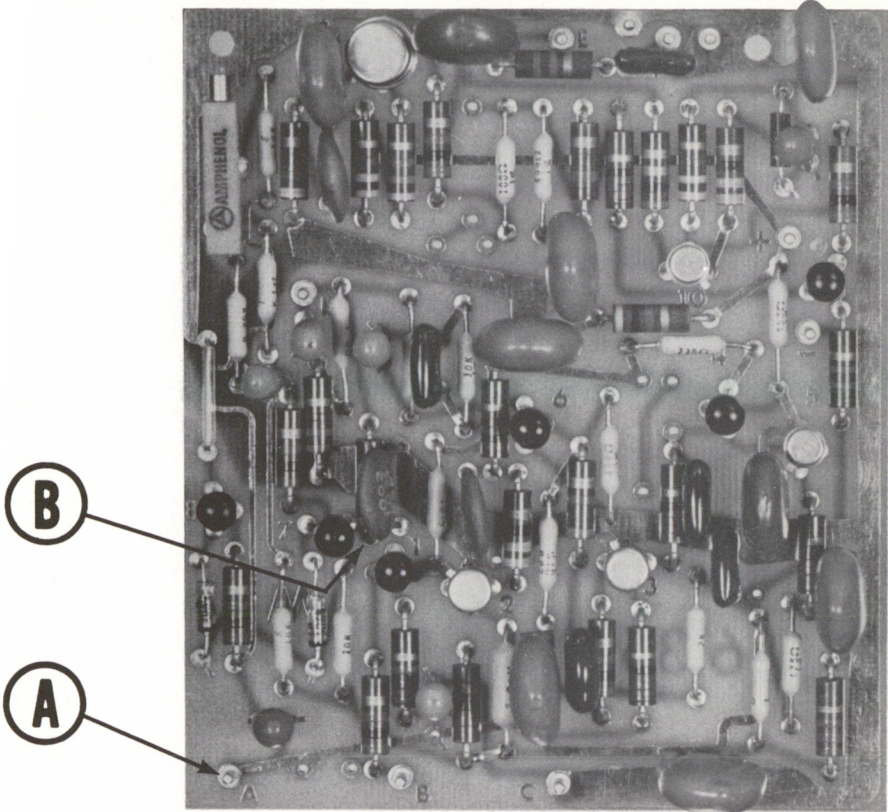
FIGURE 6 - 5 Card 6133
FREQUENCY COMPARATOR 6 - 6

6134

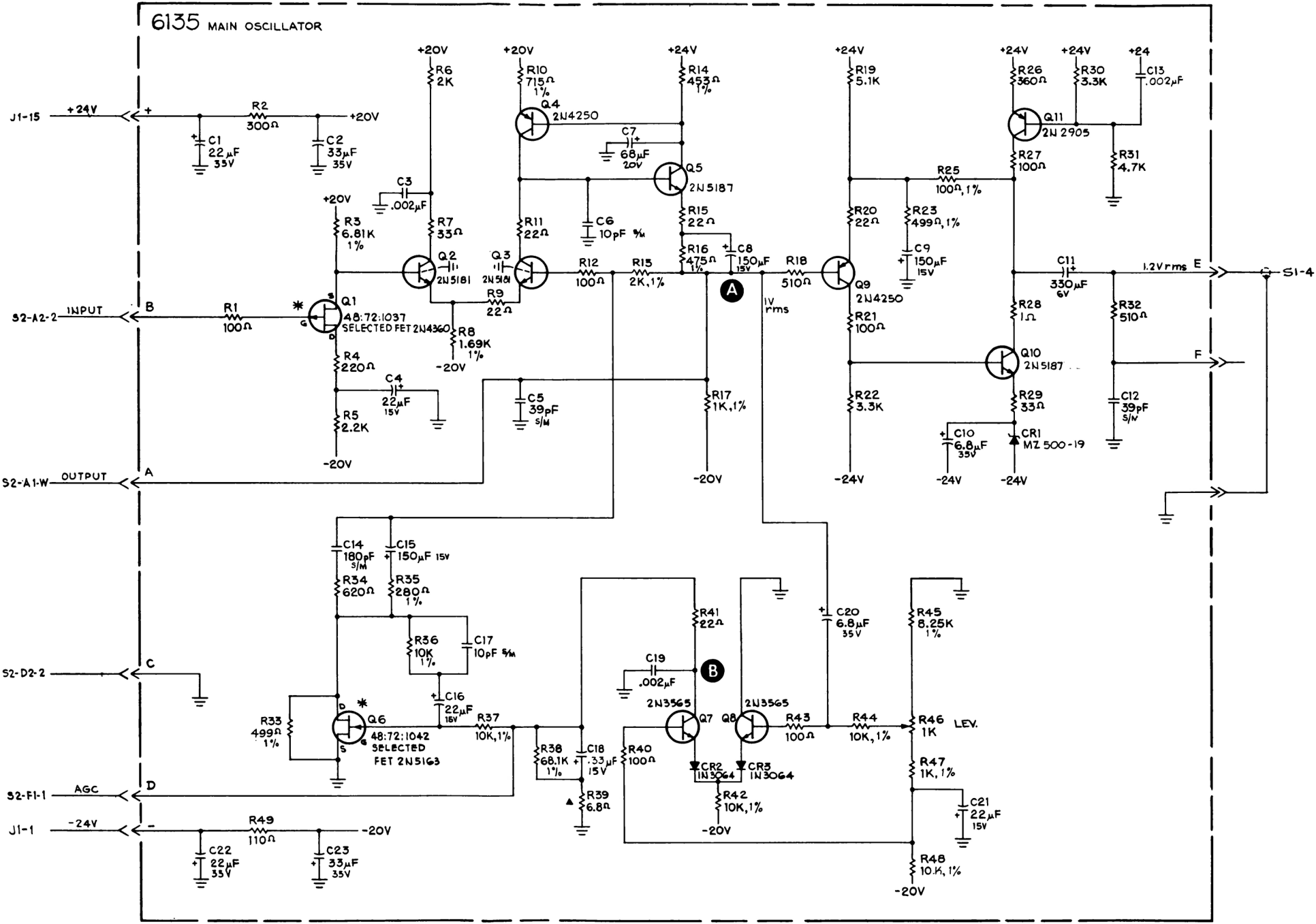


6135

Test Conditions:
Range: x10K
Dial At: "1"



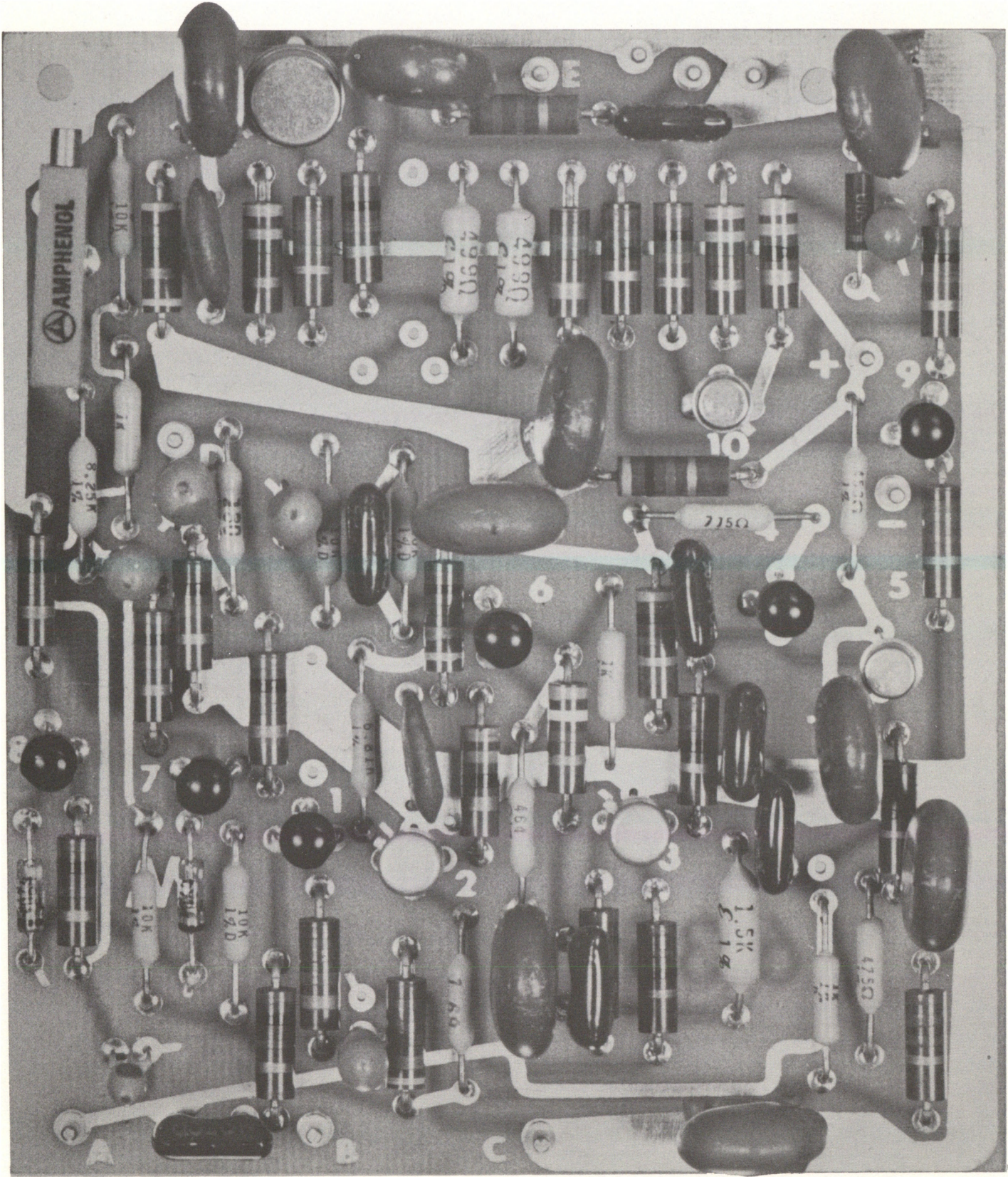
REF. DES. CHART	
LAST NO. USED	NOT USED
C 23	
CR3	
R 49	R 24
Q 11	



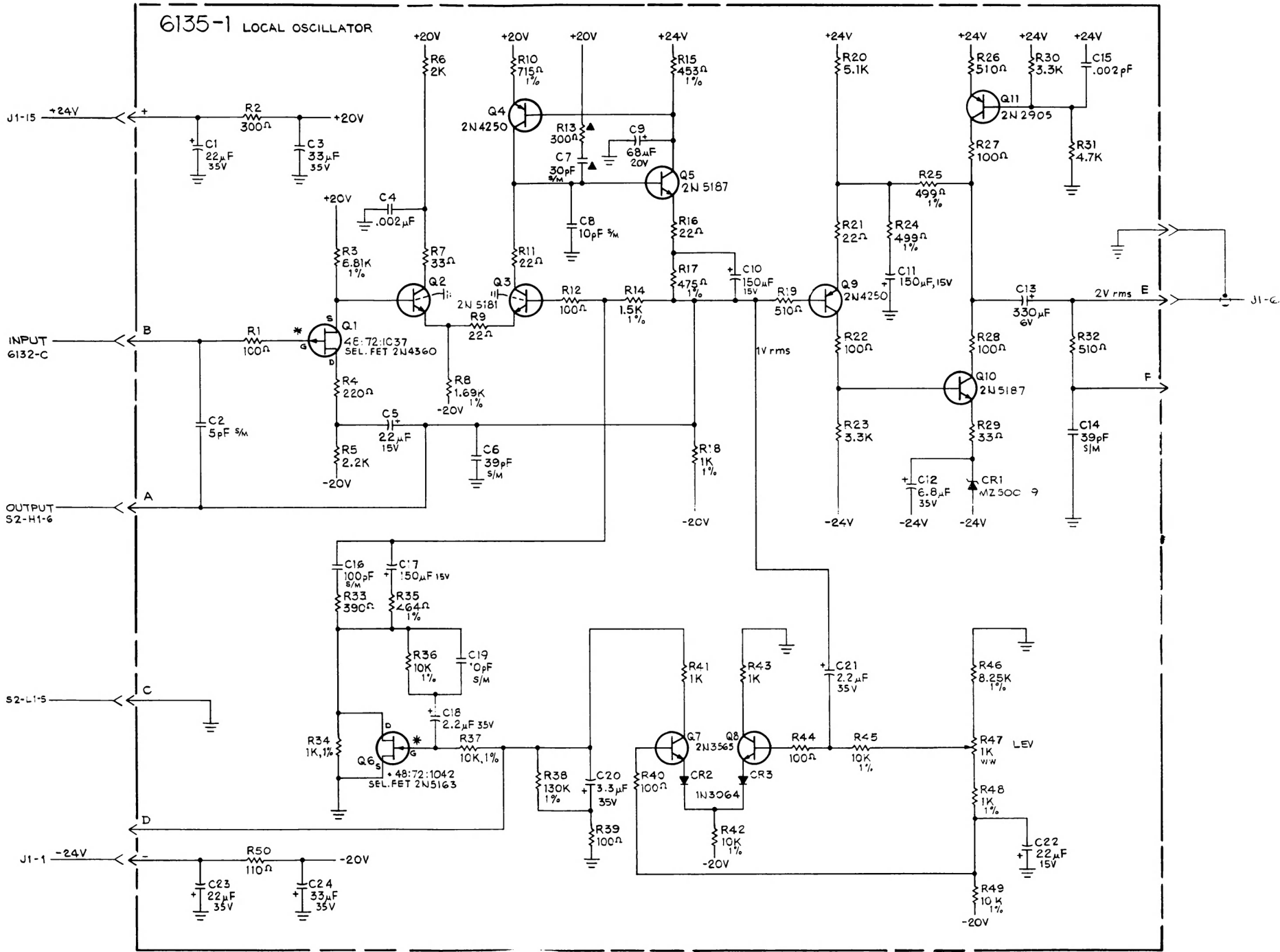
6. **A** INDICATES PHOTO POINTS.
5. ALL 1% RESISTORS ARE METAL FILM.
4. S/M INDICATES SILVER MICA.
3. UNLESS NOTED, RESISTORS ARE 1/2W, 5%.
2. * INDICATES COMPONENT SELECTED FOR PEAK VOLTAGE.
1. ▲ INDICATES NOMINAL VALUE SHOWN COMPONENT SELECTED AT CALIBRATION.
- NOTES:

FIGURE 6 - 7
Card 6135
MAIN OSCILLATOR
6 - 8

6135-1



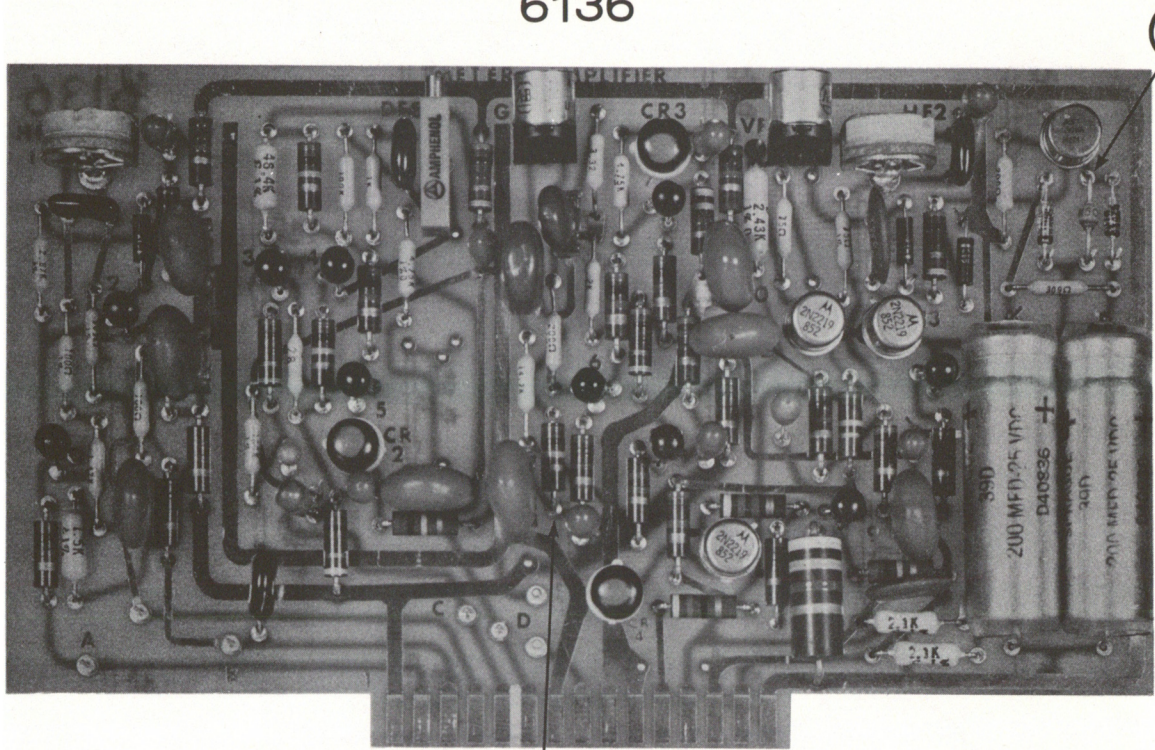
REF. DES. CHART	
LAST NO. USED	NOT USED
C 24	
C 23	
Q 11	
R 50	



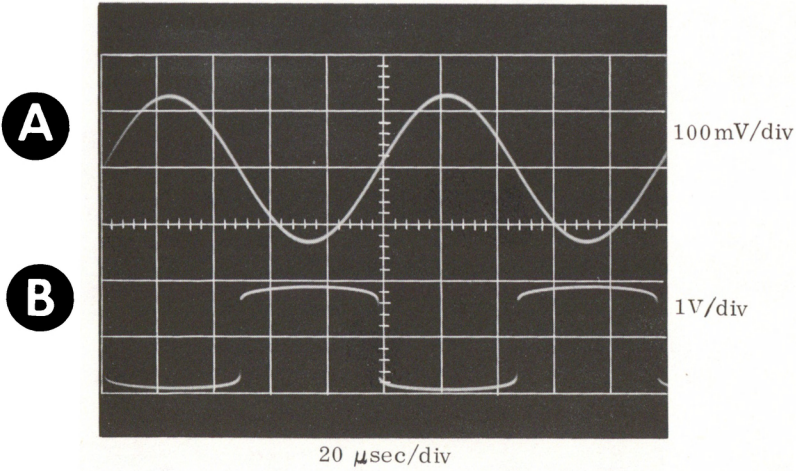
5. 5/M INDICATES SILVER MICA.
4. ALL 1% RESISTORS ARE METAL FILM.
3. UNLESS NOTED, RESISTORS ARE 1/2W, 5%.
... * INDICATES COMPONENT SELECTED FOR PEAK VOLTAGE.
1. Δ INDICATES NOMINAL VALUE SHOWN. COMPONENT SELECTED AT CALIBRATION
NOTES:

FIGURE 6 - 8
Card 6135-1
LOCAL OSCILLATOR
6 - 9

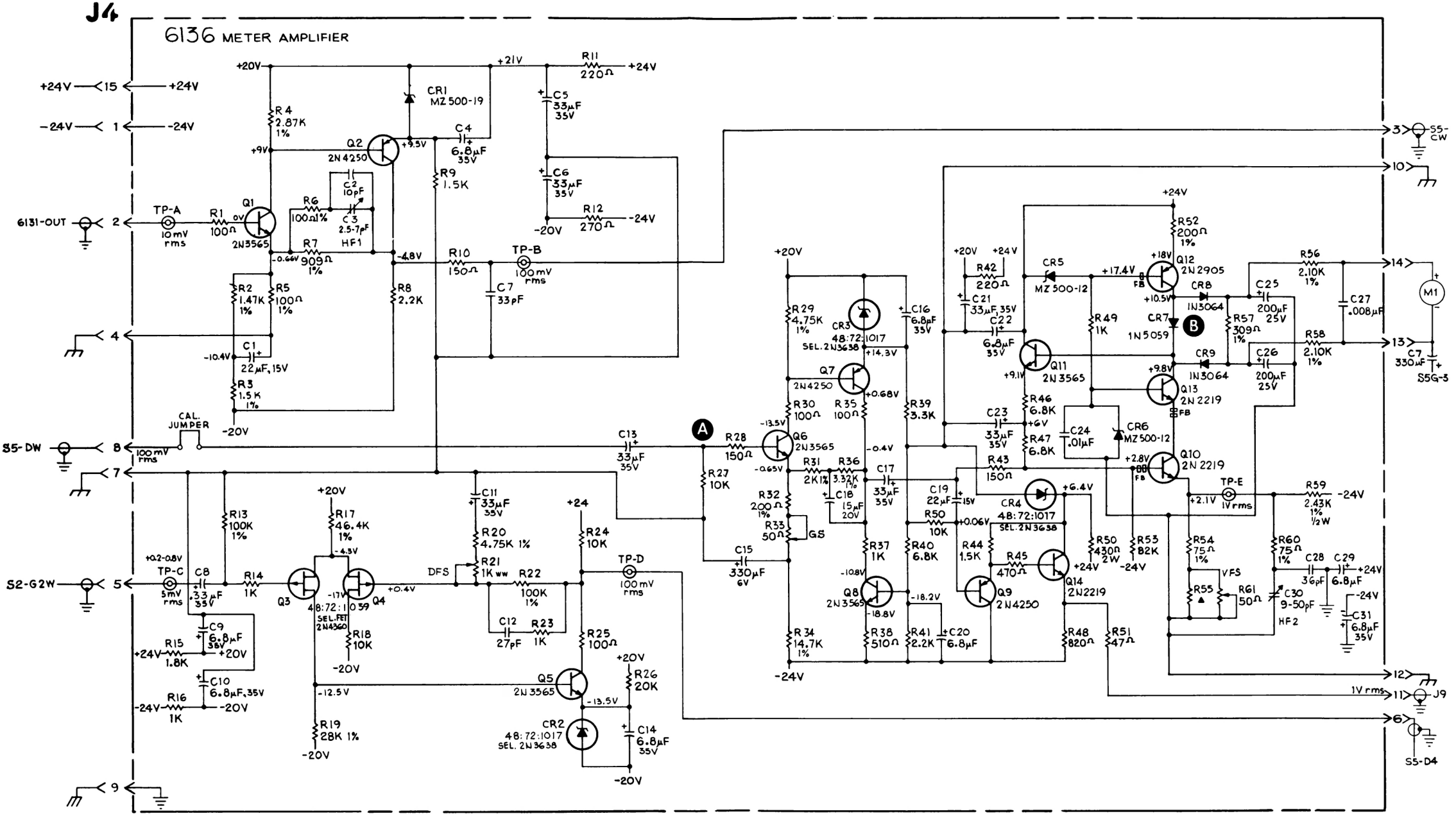
6136



Test Conditions:
Function: VM Input
Level: 1V
Input: 10 kHz @ 1V rms



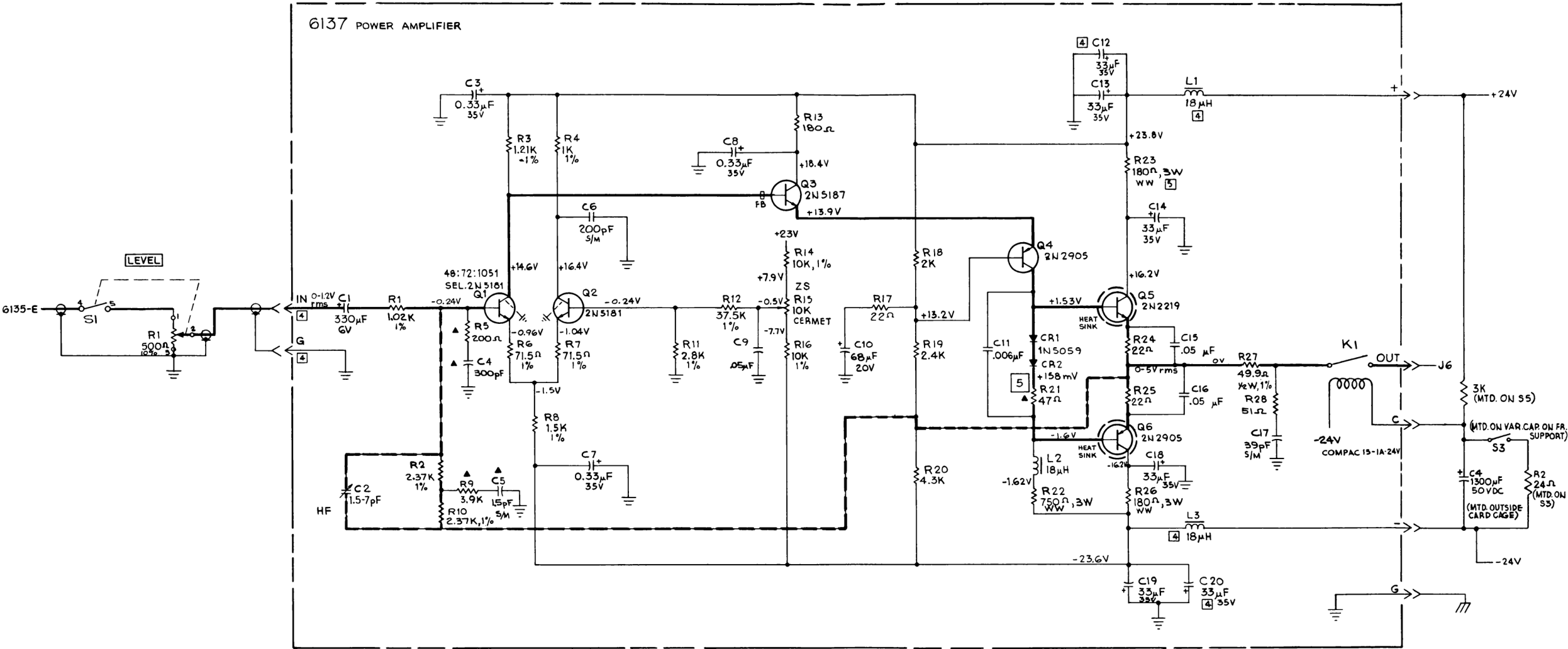
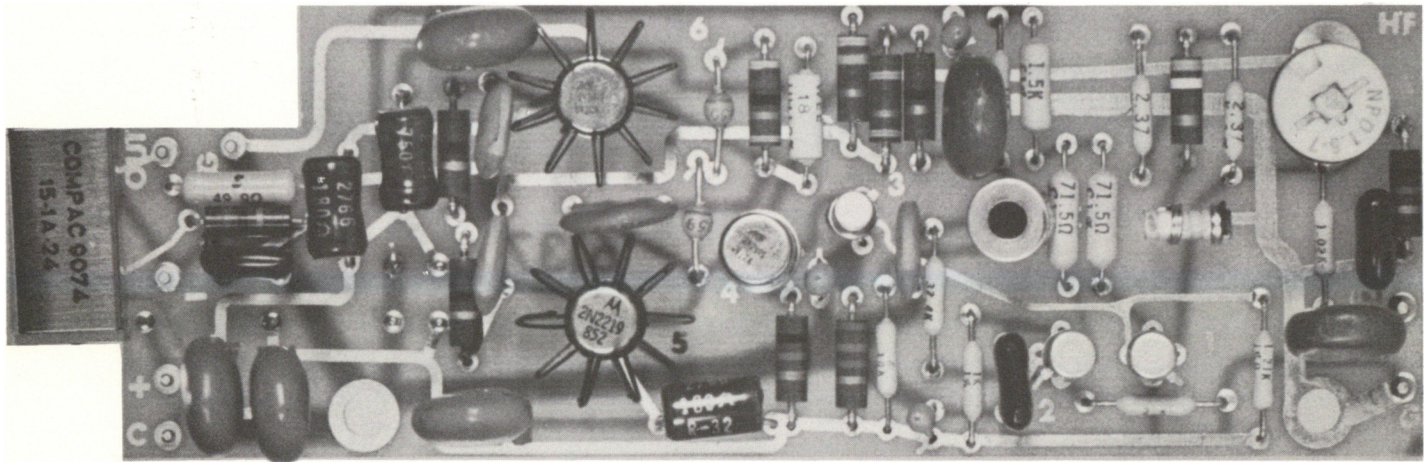
REF. DES. CHART	
LAST NO. USED	NOT USED
C 31	
CR 9	
Q 14	
R 61	



9. A INDICATES PHOTO POINTS.
8. SIGNAL LEVELS SHOWN ARE NOMINAL, FOR F.S.D.
7. ALL 1% RESISTORS ARE METAL FILM.
6. UNLESS NOTED, RESISTORS ARE 1/2 W, 5%.
5. 5% INDICATES SILVER MICA.
4. FB INDICATES FERITE BEAD.
3. TP INDICATES TEST POINT.
2. ▲ INDICATES NOMINAL VALUE SHOWN COMPONENT SELECTED IN CALIBRATION.
1. — — — INDICATES CIRCUIT CARD OUTLINE.
NOTES:

FIGURE 6 - 9
Card 6136
METER AMPLIFIER
6 - 10

6137



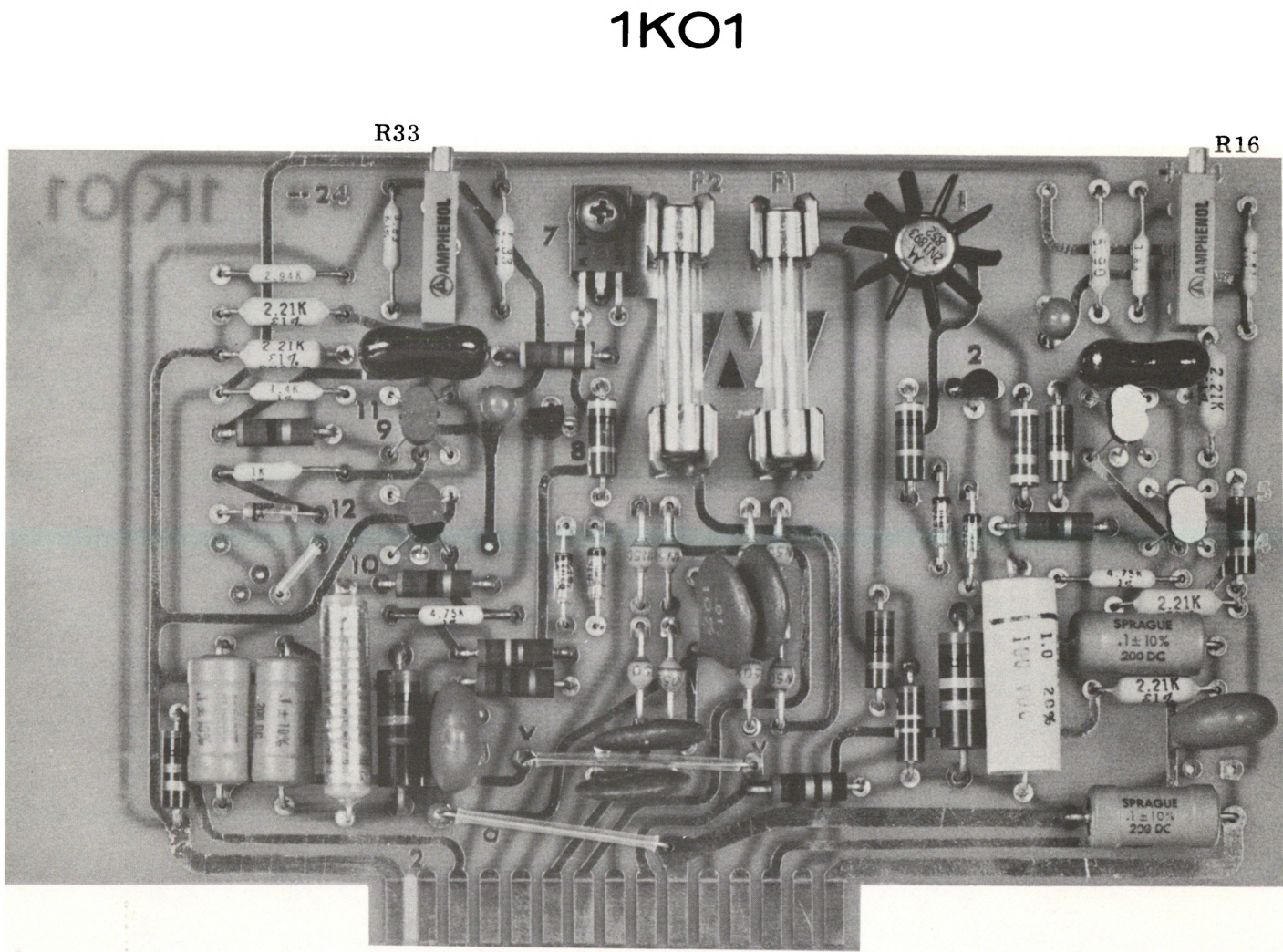
12. VOLTAGES SHOWN ARE APPROXIMATE (USED ONLY AS A REFERENCE).
11. F.B INDICATES FERRITE BEAD.
10. 9/M INDICATES SILVER MICA.
9. ALL 1% RESISTORS ARE METAL FILM.
8. UNLESS OTHERWISE NOTED, RESISTORS ARE 1/2 W, 5%.
7. ——— INDICATES SIGNAL FLOW.
6. — — — INDICATES FEEDBACK PATH.
5 VALUE CHOSEN TO GIVE 7.2V ACROSS R 23.
4 PART MOUNTED ON REVERSE SIDE OF CIRCUIT BOARD
3. ▲ INDICATES NOMINAL VALUE SHOWN COMPONENT SELECTED IN CALIBRATION.
2. [] INDICATES FRONT PANEL MARKING.
1. — — — — — INDICATES CIRCUIT CARD OUTLINE .

NOTES:

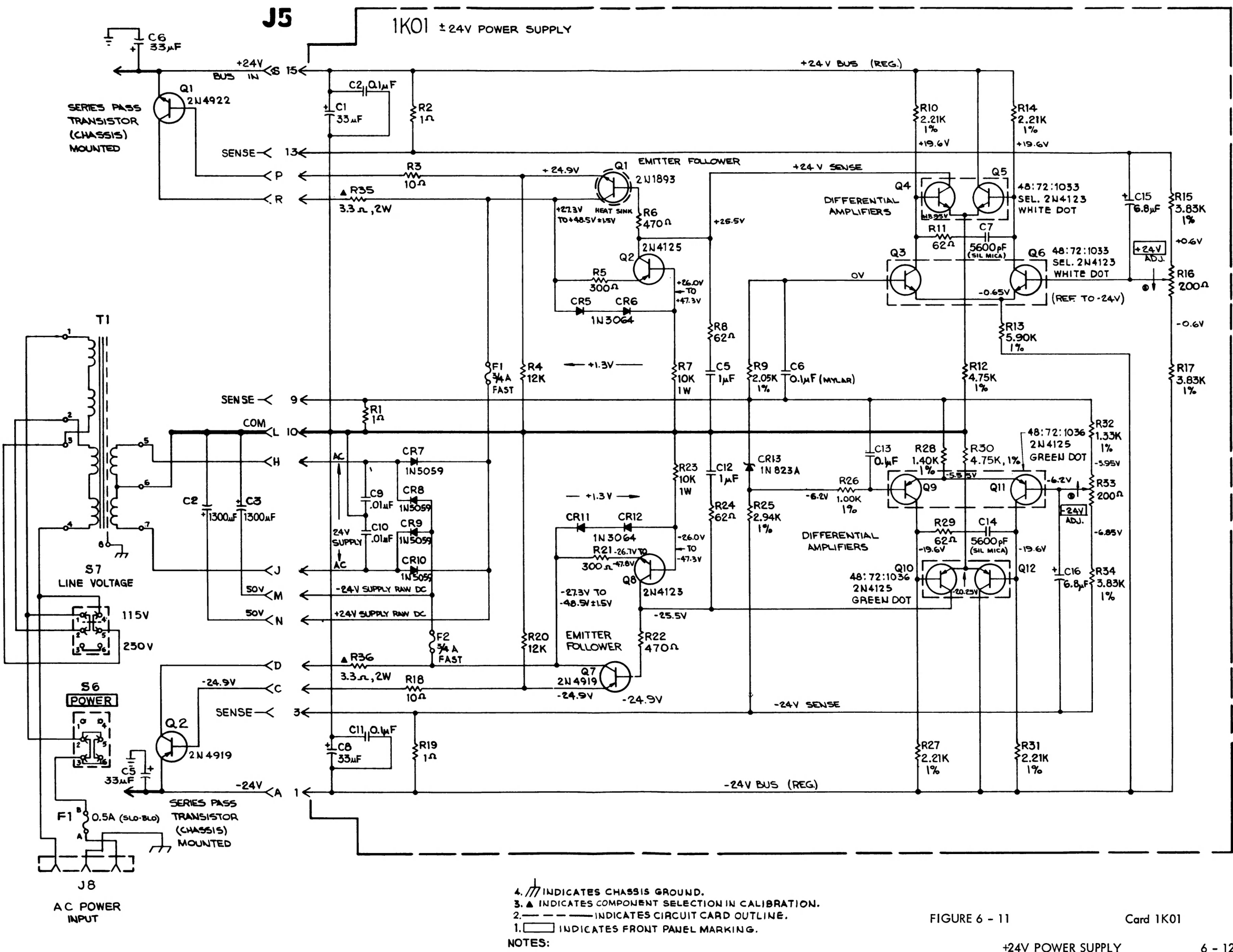
REF.	DES.	CHART
LAST NO.	USED	NOT USED
C 20		
C R 2		
K 1		
L 3		
Q 6		
R 28		

FIGURE 6 - 10

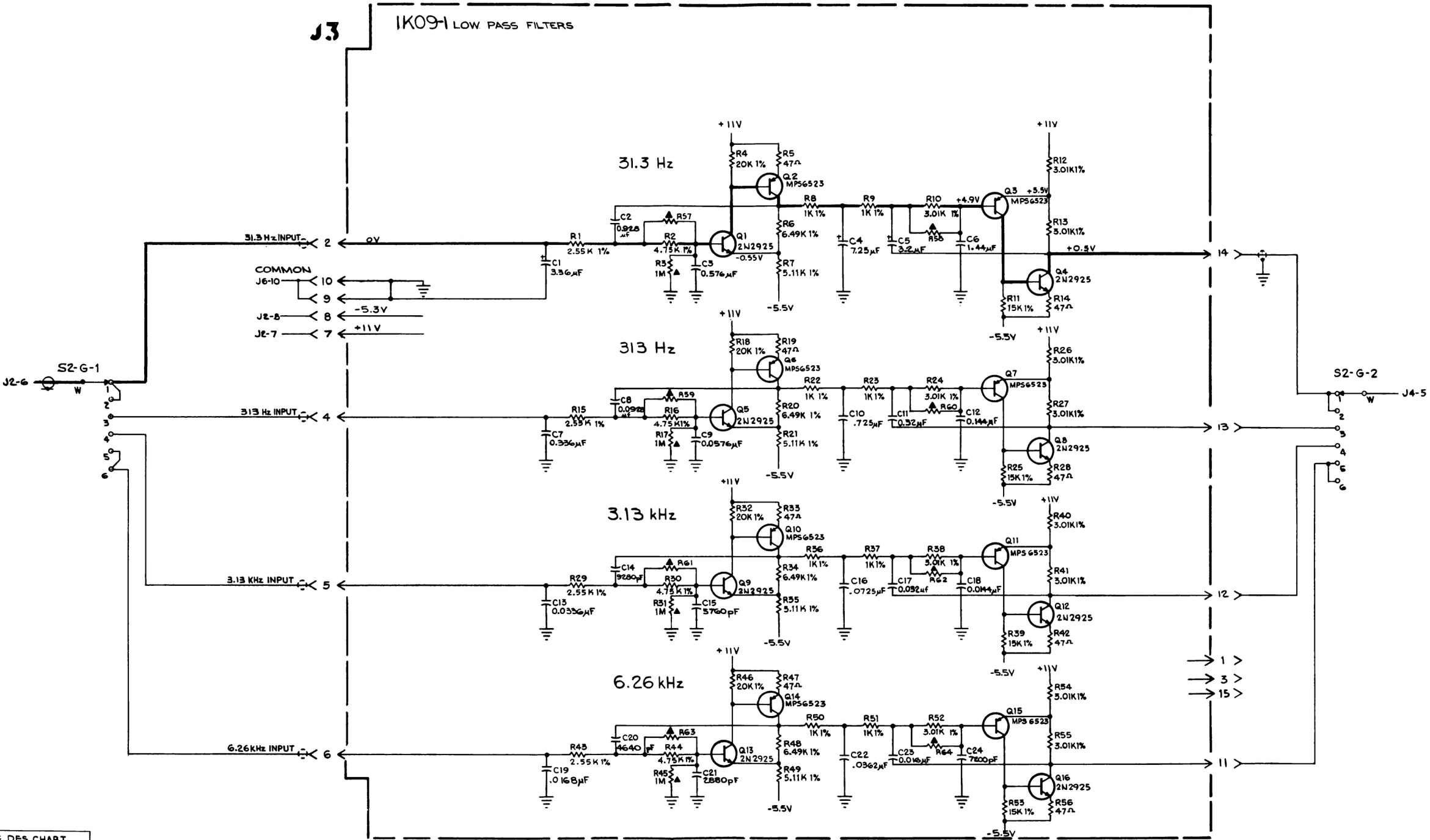
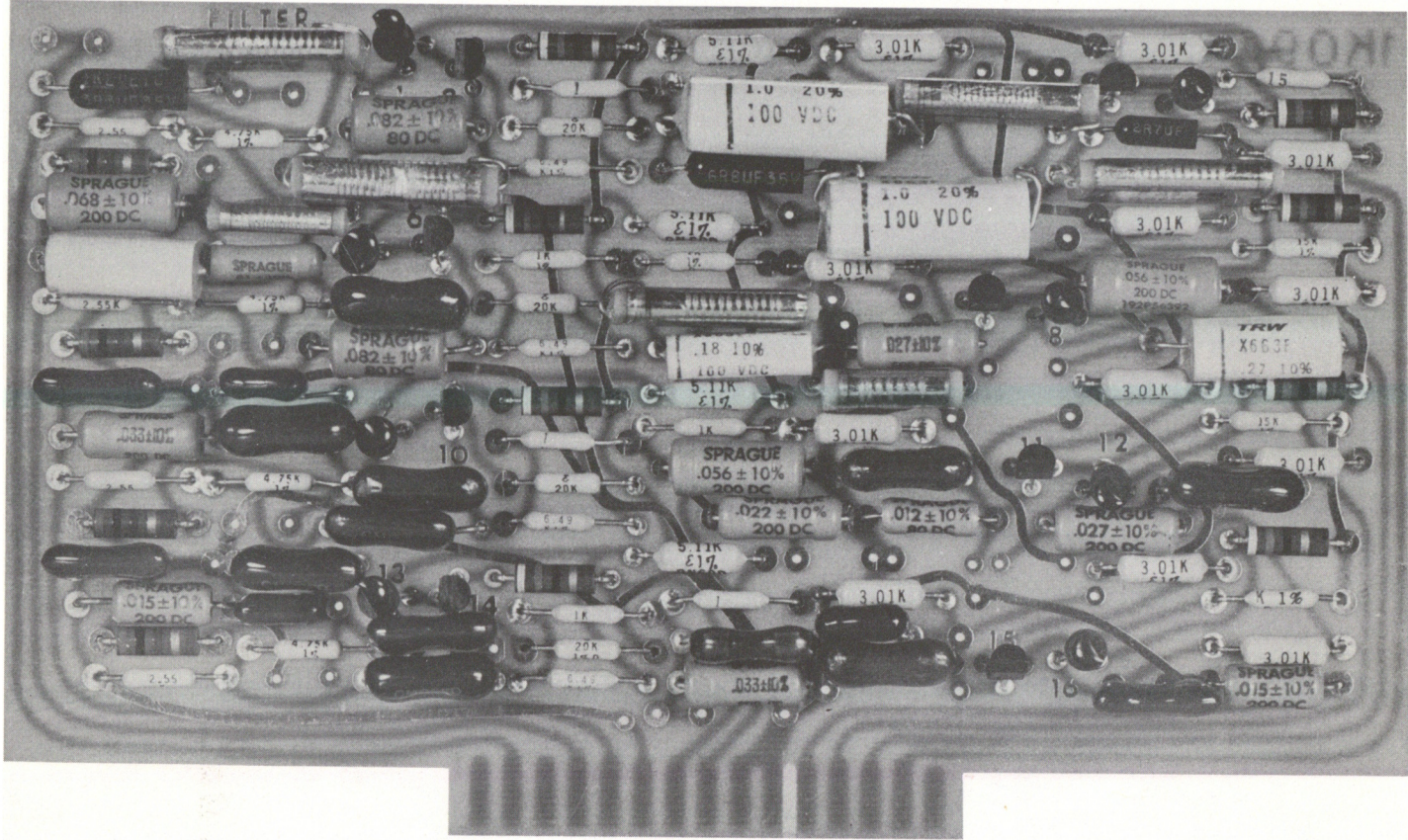
Card 6137



1K01



1K09-1



REF. DES. CHART		
LAST NO. USED	NOT USED	
C24		
R64		
Q16		

3. ALL 1% RESISTORS ARE METAL FILM.
2. UNLESS NOTED, RESISTORS ARE 1/2 W, 5%.
1. ▲ INDICATES NOMINAL VALUE, COMPONENT SELECTED IN CALIBRATION.

NOTES:

FIGURE 6 - 12 Card 1K09-1

SECTION VII

TABLE OF REPLACEABLE PARTS

7-1 This section contains information for ordering replacement parts.

7-2 To obtain replacement parts, address your order to:
Service Department
MICOM, Incorporated
855 Commercial Street
Palo Alto, California 94303

7-3 Specify the following information for each part ordered:

- a. Model and complete serial number of the instrument
- b. MICOM stock number
- c. Circuit reference designator and description

For non-listed parts, include the model and serial numbers, a description of the part, and the function and location of the part.

REFERENCE DESIGNATORS

A	assembly	J	jack	R	resistor
C	capacitor	K	relay	S	switch
CR	diode	L	inductor	T	transformer
DS	lamp	M	meter	V	vacuum tube, photocell, etc.
F	fuse	MP	mechanical part	W	cable
FF	flip-flop	P	plug	Y	crystal
FL	filter	Q	transistor	Z	network

ABBREVIATIONS

A	Ampere	d	10^{-1}	Ge	germanium
dB	decibel	m	10^{-3}	int cir	integrated circuit
F	Farad	μ	10^{-6}	M/F	metal film
H	Henry	n	10^{-9}	my	mylar
Hz	Hertz (cycle per second)	p	10^{-12}	poly	polystyrene
V	Volt			poly c	polycarbonate
W	Watt	al elect	aluminum electrolytic	Si	silicon
		cer	ceramic	sil mica	silver mica
M	10^6	comp	composition	Ta	tantalum
K	10^3	FET	field effect transistor	var	variable
D	10	fxd	fixed	ww	wirewound

▲ designates component selected in mfg. - may be omitted.

COMPANY ABBREVIATIONS

A	Arco	EM	Electromotive Mfg. Company	S	Sprague
AB	Allen Bradley	F	Fairchild	SC	Switchcraft
ANL	Amphenol	GE	General Electric	SH	Siemens and Halske
B	Bourns	GI	General Instrument	SY	Sylvania
CL	Clarostat	IRC	Internat'l. Resistance Co.	TI	Texas Instruments
CRL	Centralab	KT	Kemet	TRW	Thompson Ramo Woolridge
CTS	CTS Corporation	MO	Motorola	VK	Viking
D	Dialco	RA	Raytheon		
EL	Electra Mfg. Company	RCA	Radio Corporation of America		

SECTION VII

Table 7-1. Replaceable Parts (Cont'd)

SCHEMATIC REFERENCE	DESCRIPTION OR COMMERCIAL EQUIVALENT	DMC STOCK NO.	TQ
Card 6131 PREAMPLIFIER (Part of S4 with the following parts on P.C. Card 6131)			
C1, C2	C:fxd:Ta 33 μ F 35V 20%	15:37:3367	2
C3, C4, C6	C:fxd:Ta 330 μ F 6V 20%	15:32:3377	3
C5	C:fxd:sil mica 5pF 100V 5%	15:49:0505	1
C7	C:fxd:sil mica 12pF 100V 5%	15:49:1205	1
C8	C:fxd:sil mica 27pF 100V 5%	15:49:2705	1
C9	C:fxd:Ta 22 μ F 35V 20%	15:37:2267	1
C10, C11	C:fxd:cer 0.008 μ F 100V 10%	15:19:8026	2
CR1, CR2, CR3, CR4	diode: Si F 1N3064	48:12:1005	4
CR5	diode: Si Zener 6.5V F 2N3638, selected	48:72:1017	1
Q1	transistor: FET Si P-type F 2N4360, selected	48:72:1037	1
Q2, Q3	transistor: Si NPN RCA 2N5181	48:22:1005	2
R1, R3	R:fxd:comp 47K 5% 1/2W	47:22:4735	2
R2, R5, R12, R13	R:fxd:comp 100 ohm 5% 1/2W	47:22:1015	4
R4	R:fxd:met flm 11K 1% 1/4W	47:11:1102	1
R6	R:fxd:met flm 3.57K 1% 1/4W	47:11:3571	1
R7	R:fxd:comp 330 ohm 5% 1/2W	47:22:3315	1
R8	R:fxd:comp 270 ohm 5% 1/2W	47:22:2715	1
R9	R:fxd:met flm 1.33K 1% 1/4W	47:11:1331	1
R10	R:fxd:met flm 6.81K 1% 1/4W	47:11:6811	1
R11	R:fxd:comp 2.2K 5% 1/2W	47:22:2225	1
R14, R16	R:fxd:met flm 100 ohm 1% 1/4W	47:11:1000	2
R15, R17	R:fxd:met flm 46.4 ohm 1% 1/4W	47:11:464-	2
R18	R:fxd:comp 47 ohm 5% 1/2W	47:22:4705	1
Card 6132 AFC			
C1, C2	C:fxd:sil mica 100pF 100V	15:49:1015	2
C3	C:fxd:Ta 22 μ F 35V	15:37:2266	1
C4	C:fxd:cer 0.008 μ F 100V	15:19:8026	1
C5, C6, C7	C:fxd:cer 800pF 100V	15:19:8016	3
CR1	diode: Si F 1N3064	48:12:1005	1
K1	Relay DPDT Reed-type 24VDC Sigma 62R2	45:11:0701	1
Q1, Q2	transistor: Si F 2N4360 P-type selected	48:72:1038	2
Q3	transistor: Si F 2N4250 PNP	48:22:1039	1
Q4, Q5	transistor: Si F 2N5163 N-type selected	48:72:1043	2
R1, R2	R:fxd:comp 22M 5% 1/2W	47:22:2265	2
R3	R:fxd:comp 200K 5% 1/2W	47:22:2045	1
R4	R:fxd:comp 13K 5% 1/2W	47:22:1335	1
R5	R:fxd:comp 12K 5% 1/2W	47:22:1235	1
R6, R7	R:fxd:comp 1M 5% 1/2W	47:22:1055	2
R9	R:fxd:met flm 1.10K 1% 1/4W	47:11:1181	1
R10, R14	R:fxd:met flm 237 ohm 1% 1/4W	47:11:2370	2
R12	R:fxd:met flm 649 ohm 1% 1/4W	47:11:6490	1
R8, R11, R13, R15	R:fxd:met flm 10K 1% 1/4W	47:11:1002	4

Table 7-1. Replaceable Parts (Cont'd)

SECTION VII

SCHEMATIC REFERENCE	DESCRIPTION OR COMMERCIAL EQUIVALENT	DMC STOCK NO.	TQ
R83	R:var:ww 5K 15T 1W	47:53:502C	1
R84	R:fxd:met flm 26.1K 1% 1/4W	47:11:2612	1
R86, R88	R:fxd:comp 100K 5% 1/2W	47:22:1045	2
R89	R:fxd:comp 2.4K 5% 1/2W	47:22:2425	1
R91	R:fxd:comp 1.2K 5% 1/2W	47:22:1225	1
R92	R:fxd:comp 12K 5% 1/2W	47:22:1235	1
R93	R:fxd:comp 2.2K 5% 1/2W	47:22:2225	1
R94, R104	R:fxd:comp 220K 5% 1/2W	47:22:2245	2
R98, R103	R:fxd:comp 1.8K 5% 1/2W	47:22:1825	2
R102	R:fxd:comp 6.2K 5% 1/2W	47:22:6225	1

Card 6135 MAIN OSCILLATOR

C1, C22	C:fxd:Ta 22 μ F 35V 20%	15:37:2267	2
C2, C23	C:fxd:Ta 33 μ F 35V 20%	15:37:3367	2
C3, C13, C19	C:fxd:cer 0.002 μ F 100V 10%	15:19:2026	3
C4, C16, C18, C21	C:fxd:Ta 22 μ F 15V 20%	15:34:2267	4
C5, C12	C:fxd:sil mica 39pF 100V 5%	15:49:3905	2
C6, C17	C:fxd:sil mica 10pF 100V 5%	15:49:1005	2
C7	C:fxd:Ta 68 μ F 20V 20%	15:35:6867	1
C8, C9, C15	C:fxd:Ta 150 μ F 15V 20%	15:34:1577	3
C10, C20	C:fxd:Ta 6.8 μ F 35V 20%	15:37:6857	2
C11	C:fxd:Ta 330 μ F 6V 20%	15:32:3377	1
C14	C:fxd:sil mica 180pF 100V 5%	15:49:1815	1
CR1	diode:Si Zener 13V MO MZ500-19	48:62:1031	1
CR2, CR3	diode:Si F 1N3064	48:12:1005	2
Q1	FET:Si P-type F 2N4360 selected	48:72:1037	1
Q2, Q3	transistor:Si NPN RCA 2N5181	48:22:1005	2
Q4, Q9	transistor:Si PNP F2N4250	48:22:1039	2
Q5, Q10	transistor:Si NPN RCA 2N5187	48:22:1002	2
Q6	FET:Si N-type F 2N5163 selected	48:72:1042	1
Q7, Q8	transistor:Si NPN F 2N3565	48:22:1040	2
Q11	transistor:Si PNP MO 2N2905	48:22:2015	1
R1, R12, R21, R27, R40, R43	R:fxd:comp 100 ohm 5% 1/2W	47:22:1015	6
R2	R:fxd:comp 300 ohm 5% 1/2W	47:22:3015	1
R3	R:fxd:met flm 6.81K 1% 1/4W	47:11:6811	1
R4	R:fxd:comp 220 ohm 5% 1/2W	47:22:2215	1
R5	R:fxd:comp 2.2K 5% 1/2W	47:22:2225	1
R6	R:fxd:comp 2K 5% 1/2W	47:22:2025	1
R7, R29	R:fxd:comp 33 ohm 5% 1/2W	47:22:3305	2
R8	R:fxd:met flm 1.69K 1% 1/4W	47:11:1691	1
R9, R11, R15, R20, R41	R:fxd:comp 22 ohm 5% 1/2W	47:22:2205	5
R10	R:fxd:met flm 715 ohm 1% 1/4W	47:11:7150	1
R13	R:fxd:met flm 2K 1% 1/4W	47:11:2001	1
R14	R:fxd:met flm 453 ohm 1% 1/4W	47:11:4530	1
R16	R:fxd:met flm 475 ohm 1% 1/4W	47:11:4750	1
R17, R47	R:fxd:met flm 1K 1% 1/4W	47:11:1001	2
R18, R32	R:fxd:comp 510 ohm 5% 1/2W	47:22:5115	2
R19	R:fxd:comp 5.1K 5% 1/2W	47:22:5125	1
R22, R30	R:fxd:comp 3.3K 5% 1/2W	47:22:3325	2
R23, R33	R:fxd:met flm 499 ohm 1% 1/4W	47:11:4990	2
R25	R:fxd:met flm 100 ohm 1% 1/4W	47:11:1000	1
R26	R:fxd:comp 360 ohm 5% 1/2W	47:22:3615	1
R28	R:fxd:comp 1 ohm 5% 1/2W	47:22:0105	1
R31	R:fxd:comp 4.7K 5% 1/2W	47:22:4725	1
R34	R:fxd:comp 620 ohm 5% 1/2W	47:22:6215	1
R35	R:fxd:met flm 280 ohm 1% 1/4W	47:11:2800	1
R36, R37, R42, R44, R48	R:fxd:met flm 10K 1% 1/4W	47:11:1002	5
R38	R:fxd:met flm 68.1K 1% 1/4W	47:11:6812	1

SECTION VII

Table 7-1. Replaceable Parts (Cont'd)

SCHEMATIC REFERENCE	DESCRIPTION OR COMMERCIAL EQUIVALENT	DMC STOCK NO.	TQ
R39	R:fxd:comp 6.8 ohm 5% 1/2W	47:22:0685	1
R45	R:fxd:met flm 8.25K 1% 1/4W	47:11:8251	1
R46	R:var:ww 1K 15T 1W	47:53:102C	1
R49	R:fxd:comp 110 ohm 5% 1/2W	47:22:1115	1

Card 6135-1 LOCAL OSCILLATOR

C1, C23	C:fxd:Ta 22 μ F 35V 20%	15:37:2267	2
C2	C:fxd:sil mica 5pF 100V 5%	15:49:0505	1
C3, C24	C:fxd:Ta 33 μ F 35V 20%	15:37:3367	2
C4, C15	C:fxd:cer 0.002 μ F 100V 10%	15:19:2026	2
C5, C22	C:fxd:Ta 22 μ F 15V 20%	15:34:2267	2
C6, C14	C:fxd:sil mica 39pF 100V 5%	15:49:3905	2
C7	C:fxd:sil mica 30pF 100V 5%	15:49:3005	1
C8, C19	C:fxd:sil mica 10pF 100V 5%	15:49:1005	2
C9	C:fxd:Ta 68 μ F 20V 20%	15:35:6867	1
C10, C11, C17	C:fxd:Ta 150 μ F 15V 20%	15:34:1577	3
C12	C:fxd:Ta 6.8 μ F 35V 20%	15:37:6857	1
C13	C:fxd:Ta 330 μ F 6V 20%	15:32:3377	1
C16	C:fxd:sil mica 100pF 100V 5%	15:49:1015	1
C18, C21	C:fxd:Ta 2.2 μ F 35V 20%	15:37:2257	2
C20	C:fxd:Ta 3.3 μ F 35V 20%	15:37:3357	1
CR1	diode:Si Zener MO MZ500-19	48:62:1031	1
CR2, CR3	diode:Si F 1N3064	48:12:1005	2
Q1	FET:Si P-type F 2N4360 selected	48:72:1037	1
Q2, Q3	transistor:Si NPN RCA 2N5181	48:22:1005	2
Q4, Q9	transistor:Si PNP F 2N4250	48:22:1039	2
Q5, Q10	transistor:Si NPN RCA 2N5187	48:22:1002	2
Q6	FET:Si N-type F 2N5163 selected	48:72:1042	1
Q7, Q8	transistor:Si NPN F 2N3565	48:22:1040	2
Q11	transistor:Si PNP MO 2N2905	48:22:2015	1
R1, R12, R22, R27, R28, R39, R40, R44	R:fxd:comp 100 ohm 5% 1/2W	47:22:1015	8
R2, R13	R:fxd:comp 300 ohm 5% 1/2W	47:22:3015	2
R3	R:fxd:met flm 6.81K 1% 1/4W	47:11:6811	1
R4	R:fxd:comp 220 ohm 5% 1/2W	47:22:2215	1
R5	R:fxd:comp 2.2K 5% 1/2W	47:22:2225	1
R6	R:fxd:comp 2K 5% 1/2W	47:22:2025	1
R7, R29	R:fxd:comp 33 ohm 5% 1/2W	47:22:3305	2
R8	R:fxd:met flm 1.69K 1% 1/4W	47:11:1691	1
R9, R11, R16, R21	R:fxd:comp 22 ohm 5% 1/2W	47:22:2205	4
R10	R:fxd:met flm 715 ohm 1% 1/4W	47:11:7150	1
R14	R:fxd:met flm 1.5K 1% 1/4W	47:11:1501	1
R15	R:fxd:met flm 453 ohm 1% 1/4W	47:11:4530	1
R17	R:fxd:met flm 475 ohm 1% 1/4W	47:11:4750	1
R18, R34, R48	R:fxd:met flm 1K 1% 1/4W	47:11:1001	3
R19, R26, R32	R:fxd:comp 510 ohm 5% 1/2W	47:22:5115	3
R20	R:fxd:comp 5.1K 5% 1/2W	47:22:5125	1
R23, R30	R:fxd:comp 3.3K 5% 1/2W	47:22:3325	2
R24, R25	R:fxd:met flm 499 ohm 1% 1/4W	47:11:4990	2
R31	R:fxd:comp 4.7K 5% 1/2W	47:22:4725	1
R33	R:fxd:comp 390 ohm 5% 1/2W	47:22:3915	1
R35	R:fxd:met flm 464 ohm 1% 1/4W	47:11:4640	1
R36, R37, R42, R45, R49	R:fxd:met flm 10K 1% 1/4W	47:11:1002	5
R38	R:fxd:met flm 130K 1% 1/4W	47:11:1303	1
R41, R43	R:fxd:comp 1K 5% 1/2W	47:22:1025	2
R46	R:fxd:met flm 8.25K 1% 1/4W	47:11:8251	1
R47	R:var:ww 1K 15T 1W	47:53:102C	1
R50	R:fxd:comp 110 ohm 5% 1/2W	47:22:1115	1

Table 7-1. Replaceable Parts (Cont'd)

SECTION VII

SCHEMATIC REFERENCE	DESCRIPTION OR COMMERCIAL EQUIVALENT	DMC STOCK NO.	TQ
Card 6136 METER AMPLIFIER			
C1	C:fxd:Ta 22 μ F 35V 20%	15:37:2267	1
C2	C:fxd:sil mica 10pF 100V 5%	15:49:1005	1
C3	C:var:cer 2.5-7pF	15:59:070W	1
C4, C9, C10, C14, C16, C20, C22, C29, C31	C:fxd:Ta 6.8 μ F 35V 20%	15:37:6857	9
C5, C6, C11, C13, C17, C21, C23	C:fxd:Ta 33 μ F 35V 20%	15:37:3367	7
C7	C:fxd:sil mica 33pF 100V 5%	15:49:3305	1
C8	C:fxd:Ta 0.33 μ F 35V 20%	15:37:3347	1
C12	C:fxd:sil mica 27pF 100V 5%	15:49:2705	1
C15	C:fxd:Ta 330 μ F 6V 20%	15:32:3377	1
C18	C:fxd:Ta 15 μ F 20V 20%	15:35:1567	1
C19	C:fxd:Ta 22 μ F 15V 20%	15:34:2267	1
C24	C:fxd:cer 0.01 μ F 100V 10%	15:19:1036	1
C25, C26	C:fxd:alum 200 μ F 25V 25%	15:76:2078	2
C27	C:fxd:cer 0.008 μ F 100V 10%	15:19:8026	1
C28	C:fxd:sil mica 36pF 100V 5%	15:49:3605	1
C30	C:var:cer 9-50pF	15:59:500W	1
CR1	diode:Si Zener 13V MO MZ500-19	48:62:1031	1
CR2, CR3, CR4	diode:Si Zener 6.5V F 2N3638 selected	48:72:1017	3
CR5, CR6	diode:Si Zener 6.3V MO MZ500-12	48:62:1032	2
CR7	diode:Si GE 1N5059	48:12:1015	1
CR8, CR9	diode:Si F 1N3064	48:12:1005	2
Q1, Q5, Q6, Q8, Q11	transistor:Si NPN F 2N3565	48:22:1040	5
Q2, Q7, Q9	transistor:Si PNP F 2N4250	48:22:1039	3
Q3, Q4	FET:Si P-type F 2N4360 matched pair	48:72:1039	2
Q10, Q13, Q14	transistor:Si NPN MO 2N2219	48:22:2030	3
Q12	transistor:Si PNP MO 2N2905	48:22:2015	1
R1, R25, R30, R35	R:fxd:comp 100 ohm 5% 1/2W	47:22:1015	4
R2	R:fxd:met flm 1.47K 1% 1/4W	47:11:1471	1
R3	R:fxd:met flm 1.5K 1% 1/4W	47:11:1501	1
R4	R:fxd:met flm 2.87K 1% 1/4W	47:11:2871	1
R5, R6	R:fxd:met flm 100 ohm 1% 1/4W	47:11:1000	2
R7	R:fxd:met flm 909 ohm 1% 1/4W	47:11:9090	1
R8, R41	R:fxd:comp 2.2K 5% 1/2W	47:22:2225	2
R9, R44	R:fxd:comp 1.5K 5% 1/2W	47:22:1525	2
R10, R28, R43	R:fxd:comp 150 ohm 5% 1/2W	47:22:1515	3
R11, R42	R:fxd:comp 220 ohm 5% 1/2W	47:22:2215	2
R12	R:fxd:comp 270 ohm 5% 1/2W	47:22:2715	1
R13, R22	R:fxd:met flm 100K 1% 1/4W	47:11:1003	2
R14, R16, R23, R37, R49	R:fxd:comp 1K 5% 1/2W	47:22:1025	5
R15	R:fxd:comp 1.8K 5% 1/2W	47:22:1825	1
R17	R:fxd:met flm 46.4K 1% 1/4W	47:11:4642	1
R18, R24, R27	R:fxd:comp 10K 5% 1/2W	47:22:1035	3
R19	R:fxd:met flm 28K 1% 1/4W	47:11:2802	1
R20, R29	R:fxd:met flm 4.75K 1% 1/4W	47:11:4751	2
R21	R:var:ww 1K 15T 1W	47:53:102C	1
R26	R:fxd:comp 20K 5% 1/2W	47:22:2035	1
R31	R:fxd:met flm 2K 1% 1/4W	47:11:2001	1
R32, R52	R:fxd:met flm 200 ohm 1% 1/4W	47:11:2000	2
R33, R61	R:var:Cermet 50 ohm AB#SH5001	47:62:500C	2
R34	R:fxd:met flm 14.7K 1% 1/4W	47:11:1472	1
R36	R:fxd:met flm 3.32K 1% 1/4W	47:11:3321	1
R38	R:fxd:comp 510 ohm 5% 1/2W	47:22:5115	1
R39	R:fxd:comp 3.3K 5% 1/2W	47:22:3325	1
R40, R46, R47	R:fxd:comp 6.8K 5% 1/2W	47:22:6825	3
R45	R:fxd:comp 470 ohm 5% 1/2W	47:22:4715	1

SECTION VII

Table 7-1. Replaceable Parts (Cont'd)

SCHEMATIC REFERENCE	DESCRIPTION OR COMMERCIAL EQUIVALENT	DMC STOCK NO.	TQ
R48	R:fxd:comp 820 ohm 5% 1/2W	47:22:8215	1
R50	R:fxd:comp 430 ohm 5% 2W	47:22:4315	1
R51	R:fxd:comp 47 ohm 5% 1/2W	47:22:4705	1
R53	R:fxd:comp 82K 5% 1/2W	47:22:8235	1
R54, R60	R:fxd:met flm 75 ohm 1% 1/4W	47:11:0750	2
R55	selected in manufacturing		
R56, R58	R:fxd:met flm 2.10K 1% 1/4W	47:11:2101	2
R57	R:fxd:met flm 309 ohm 1% 1/4W	47:11:3090	1
R59	R:fxd:met flm 2.43K 1% 1/2W	47:12:2431	1

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C1	C:fxd:Ta 330 μ F 6V 20%	15:32:3377	1
C2	C:var:cer 1.5-7pF	15:59:070V	1
C3, C7, C8	C:fxd:Ta 0.33 μ F 35V 20%	15:37:3347	3
C4	C:fxd:sil mica 300pF 100V 5%	15:49:3015	1
C5	selected in manufacturing		
C6	C:fxd:sil mica 200pF 100V 5%	15:49:2015	1
C9, C15, C16	C:fxd:cer 0.05 μ F 100V 10%	15:19:5036	3
C10	C:fxd:Ta 68 μ F 20V 20%	15:35:6867	1
C11	C:fxd:cer 0.006 μ F 100V 10%	15:19:6026	1
C12, C13, C14, C18, C19, C20	C:fxd:Ta 33 μ F 35V 20%	15:37:3367	6
C17	C:fxd:sil mica 39pF 100V 5%	15:49:3905	1
CR1, CR2	diode:Si GE 1N5059	48:12:1015	2
Q1	transistor:Si NPN RCA 2N5181 selected	48:72:1051	1
Q2	transistor:Si NPN RCA 2N5181	48:22:1005	1
Q3	transistor:Si NPN RCA 2N5187	48:22:1002	1
Q4, Q6	transistor:Si PNP MO 2N2905	48:22:2015	2
Q5	transistor:Si NPN MO 2N2219	48:22:2030	1
R1	R:fxd:met flm 1.02K 1% 1/4W	47:11:1021	1
R2, R10	R:fxd:met flm 2.37K 1% 1/4W	47:11:2371	2
R3	R:fxd:met flm 1.21K 1% 1/4W	47:11:1211	1
R4	R:fxd:met flm 1K 1% 1/4W	47:11:1001	1
R5	R:fxd:comp 200 ohm 5% 1/2W	47:22:2015	1
R6, R7	R:fxd:met flm 71.5 ohm 1% 1/4W	47:11:715-	2
R8	R:fxd:met flm 1.5K 1% 1/4W	47:11:1501	1
R9	R:fxd:comp 3.9K 5% 1/2W	47:22:3925	1
R11	R:fxd:met flm 2.8K 1% 1/4W	47:11:2801	1
R12	R:fxd:met flm 37.5K 1% 1/4W	47:11:3752	1
R13	R:fxd:comp 180 ohm 5% 1/2W	47:22:1815	1
R14, R16	R:fxd:met flm 10K 1% 1/4W	47:11:1002	2
R15	R:var:Cermet 10K AB#SV1031	47:62:103F	1
R17, R24, R25	R:fxd:comp 22 ohm 5% 1/2W	47:22:2205	3
R18	R:fxd:comp 2K 5% 1/2W	47:22:2025	1
R19	R:fxd:comp 2.4K 5% 1/2W	47:22:2425	1
R20	R:fxd:comp 4.3K 5% 1/2W	47:22:4325	1
R21	selected in manufacturing		
R22	R:fxd:ww 750 ohm 5% 3W	47:35:7505	1
R23, R26	R:fxd:comp 180 ohm 5% 3W	47:35:1805	2
R27	R:fxd:met flm 49.9 ohm 1% 1/2W	47:12:499-	1
R28	R:fxd:comp 51 ohm 5% 1/2W	47:22:5105	1
L1, L2, L3	WEEDUCTOR 18 μ h	18:23:1805	3
K1	Relay Compac 15-1A-24V	45:11:0700	1

Table 7-1. Replaceable Parts (Cont'd)

SECTION VII

SCHEMATIC REFERENCE	DESCRIPTION OR COMMERCIAL EQUIVALENT	DMC STOCK NO.	TQ
Card 1K09-1 LOW PASS FILTERS			
C1 --C24	selected in manufacturing (nominals shown on schematic)		
Q1, Q4, Q5, Q8, Q9, Q12, Q13, Q16	transistor:Si NPN GE 2N2925	48:22:1004	8
Q2, Q3, Q6, Q7, Q10, Q11 Q14, Q15	transistor:Si PNP MO MPS6523	48:22:1029	8
R1, R15, R29, R43	R:fxd:met flm 2.55K 1% 1/4W	47:11:2551	4
R2, R16, R30, R44	R:fxd:met flm 4.75K 1% 1/4W	47:11:4751	4
R3, R17, R31, R45	R:fxd:comp 1M 5% 1/2W	47:22:1055	4
R4, R18, R32, R46	R:fxd:met flm 20K 1% 1/4W	47:11:2002	4
R5, R14, R19, R28, R33, R42, R47, R56	R:fxd:comp 47 ohm 5% 1/2W	47:22:4705	8
R6, R20, R34, R48	R:fxd:met flm 6.49K 1% 1/4W	47:11:6491	4
R7, R21, R35, R49	R:fxd:met flm 5.11K 1% 1/4W	47:11:5111	4
R8, R9, R22, R23, R36, R37, R50, R51	R:fxd:met flm 1K 1% 1/4W	47:11:1001	8
R10, R12, R13, R24, R26, R27, R38, R40, R41, R52, R54, R55	R:fxd:met flm 3.01K 1% 1/4W	47:11:3011	12
R11, R25, R39, R53	R:fxd:met flm 15K 1% 1/4W	47:11:1502	4
R57 - R64	selected in manufacturing		
Card 1K01 REGULATED POWER SUPPLY			
C1, C8	C:fxd:Ta 33 μ F 35V 20% KT "E" Series	15:37:3367	2
C2, C6, C11, C13	C:fxd:met my 0.1 μ F 200V 10%	15:29:1046	4
C3, C4, C9, C10	C:fxd:cer .01 μ F 100V 10%	15:19:1036	4
C5, C12	C:fxd:met my 1.0 μ F 250V 20%	15:29:1057	2
C7, C14	C:fxd:sil mica 5600pF 5%	15:49:5625	2
C15, C16	C:fxd:Ta 6.8 μ F 35V 20% KT "E" Series	15:37:6857	2
CR1, CR2, CR3, CR4, CR7, CR8, CR9, CR10	diodes: Si GE 1N5059	48:12:2015	8
CR5, CR6, CR11, CR12	diodes: Si R 1N3064	48:12:1005	4
CR14	diode Zener 1N823A, 6.3V \pm 2%	48:62:1040	1
F1, F2	Fuse: 1/2A 3AG Reg	51:23:0050	2
Q1	transistor: Si NPN MO 2N1893	48:22:2035	1
Q2	transistor: Si PNP MO 2N4125	48:22:1036	1
Q3, Q6; Q4, Q5	transistor: Si NPN Matched MO 2N4123	48:72:1033	2 pr.
Q7	transistor: Si PNP MO 2N4919	48:22:2032	1
Q8	transistor: Si NPN MO 2N4123	48:22:1031	1
Q9, Q11; Q10, Q12	transistor: Si PNP Matched MO 2N4125	48:72:1036	2 pr.
R1, R2, R19	R:fxd:comp 1 ohm 1/2W 5%	47:22:0105	3
R3, R18	R:fxd:comp 10 ohm 1/2W 5%	47:22:1005	2
R4, R20	R:fxd:comp 12K 1/2W 5%	47:22:1235	2
R5, R21	R:fxd:comp 300 ohm 1/2W 5%	47:22:3015	2
R6, R22	R:fxd:comp 470 ohm 1/2W 5%	47:22:4715	2
R7, R23	R:fxd:comp 10K 1W 5%	47:23:1035	2
R8, R11, R24, R29	R:fxd:comp 62 ohm 1/2W 5%	47:22:6205	4
R9	R:fxd:met flm 2K 1/4W 1%	47:11:2001	1
R10, R14, R27, R31	R:fxd:met flm 2.21K 1/4W 1%	47:11:2211	4
R12, R30	R:fxd:met flm 4.75K 1/4W 1%	47:11:4751	2
R13	R:fxd:met flm 5.90K 1/4W 1%	47:11:5901	1
R15, R17, R34	R:fxd:met flm 3.83K 1/4W 1%	47:11:3831	3
R16, R33	R:var:200 ohm ww 15T 1W	47:53:201C	2
R35, R36	R:fxd:comp 3.3 ohm 2W 10%	47:24:0336	2

SECTION VII

Table 7-1. Replaceable Parts (Cont'd)

SCHEMATIC REFERENCE	DESCRIPTION OR COMMERCIAL EQUIVALENT	DMC STOCK NO.	TQ
S2 RANGE SWITCH			
C1, C3, C6, C9, C19, C21, C23, C24, C30, C25, C27, C29	C:adj:sil mica trimmer 4-40pF	15:69:400W	12
C18	C:fxd:met my .033 μ F 100V 10%	15:29:3336	1
C17	C:fxd:Ta 0.33 μ F 35V 20%	15:37:3347	1
C16	C:fxd:Ta 3.3 μ F 35V 20%	15:37:3357	1
C2, C4, C8, C10, C20, C22, C26, C28	C:fxd:sil mica 22pF 100V 10%	15:49:2205	8
C14	C:fxd:sil mica 2700pF 100V 5%	15:49:2725	1
C13	C:fxd:met my .068 μ F 100V 10%	15:29:6837	1
C15	C:fxd:Ta 6.8 μ F 35V 20%	15:37:6857	1
C12	C:fxd:Ta .68 μ F 35V 20%	15:37:6847	1
C11	C:fxd:sil mica 10pF 100V 5%	15:49:1005	1
C5	C:fxd:sil mica 50pF 100V 5%	15:49:5005	1
C7	C:fxd:met my .0047pF 100V 10%	15:29:4726	1
R8	R:fxd:comp 47 ohm 5% 1/2W	47:22:4705	1
R15	R:fxd:met flm 140 ohm 1% 1/2W	47:12:1400	1
R7	R:fxd:met flm 309 ohm 1% 1/4W	47:11:3090	1
R20	R:fxd:met flm 845 ohm 1% 1/4W	47:11:8450	1
R14, R31	R:fxd:met flm 1.27K 1% 1/4W	47:11:1271	2
R6	R:fxd:met flm 2.55K 1% 1/4W	47:11:2551	1
R19, R25	R:fxd:met flm 8.25K 1% 1/4W	47:11:8251	2
R36, R30	R:fxd:met flm 12.1K 1%	47:11:1212	2
R13	R:fxd:met flm 12.7K 1%	47:11:1272	1
R5	R:fxd:met flm 25.5K 1%	47:11:2552	1
R18, R24	R:fxd:met flm 82.5K 1%	47:11:8252	2
R35, R29	R:fxd:met flm 121K 1%	47:11:1213	2
R12	R:fxd:met flm 127K 1% 1/4W	47:11:1273	1
R4	R:fxd:met flm 255K 1% 1/4W	47:11:2553	1
R17, R23	R:fxd:met flm .825K 1% 1/4W	47:11:8253	2
R34, R28	R:fxd:met flm 1.21M 1% 1/2W	47:12:1214	2
R11	R:fxd:met flm 1.27M 1% 1/2W	47:12:1274	1
R3	R:fxd:pyro flm 2.55M 1% 1/2W	47:12:2554	1
R10	R:fxd:comp 10M 5% 1/2W	47:22:1065	1
R1, R2, R9	R:fxd:pyro flm 12.7M 1% 1/2W	47:12:1275	3
R16, R21, R22, R26, R33, R37, R27, R32	R:fxd:comp 100K 5% 1/2W	47:22:1045	8

Card 61S4 ATTENUATOR (S4 Switch: 2 Pol. 10 Pos. with the following parts on P.C. Card 61S4)

C1	C:fxd:met my 0.1 μ F 100V 10%	15:29:1046	1
C2, C3, C4	C:var:cer 2.5-7pF	15:59:070W	3
C5	C:fxd:sil mica 33pF 100V 5%	15:49:3305	1
C6	C:fxd:sil mica 330pF 100V 5%	15:49:3315	1
C7	C:fxd:sil mica 3900pF 100V 5%	15:49:3925	1
F1	Fuse 1/100 Amp. 250V	51:14:0001	1
R1	R:fxd:met flm 909K 1% 1/4W	47:11:9093	1
R2, R3	R:fxd:met flm 1M 1% 1/4W	47:11:1004	2
R4	R:fxd:met flm 100K 1% 1/4W	47:11:1003	1
R5	R:fxd:met flm 10K 1% 1/4W	47:11:1002	1
R6	R:fxd:met flm 1K 1% 1/4W	47:11:1001	1
R7	R:fxd:comp 130 ohm 5% 1/2W	47:22:1315	1
R8	R:fxd:comp 22 ohm 5% 1/2W	47:22:2205	1
R9, R10	R:fxd:met flm 11.5 ohm 1% 1/4W	47:11:115-	2

Table 7-1. Replaceable Parts (Cont'd)

SECTION VII

SCHEMATIC REFERENCE	DESCRIPTION OR COMMERCIAL EQUIVALENT	DMC STOCK NO.	TQ
S5 FUNCTION SWITCH (2 Pol. 4 Pos., Assy Dwg. #6100D005)			
	R:fxd:comp 330 ohm 5% 1/2W	47:22:3315	1
	R:fxd:comp 3K 5% 1/2W	47:22:3025	1
	C:fxd:Ta 330 μ F 6V 20% Kemet "E" Series	15:32:3377	1
MISCELLANEOUS COMPONENTS			
	Belt, Tmg. 1/5" Pitch 1/4" Wide	60:50:0025	1
	Bezel & Hardware	14:13:0001	1
	C:fxd:Al Electrolytic 1300 μ F 50V 20%	15:76:1387	3
	C1A - C1E C:var:Air (5 ganged) TRW# Model 17	15:99:611A	1
	Casting, outside, left Dwg. #1000E006-1	14:12:1004	1
	Casting, outside, right Dwg. #1000E006	14:12:1002	1
	Connector, BNC chassis UG657/U	21:25:0700	1
	Connector, Power A.C. (3 prong)	21:14:1803	1
	Cover, Top & Bottom Dwg. #1000E010	14:11:0003	2
	Dial, Cuped Dwg. #6100E007	24:11:1009	1
	Dial Drive Assy. Dwg. #6100D007	24:42:0002	1
	Fuse, 1/2 Amp. 250V 3AG Slo Blo	51:22:0050	1
	Handles Dwg. #1000E022	24:31:0001	2
	Holder, Fuse 3AG	21:27:1700	1
	Knob, Bar Skirted	24:22:0010	3
	Knob, Round White Dot Raytheon 70-ZWD-ZG	24:22:0017	1
	Lamps, Amber 28V 40mA	39:13:2840	3
	Meter Assy. 0-200 μ A	29:31:6100	1
	Panel, Front Dwg. #6100E001	24:11:6100	1
	Power Cord (3 prong) Belden #18-3	60:52:0018	1 ea
	Pulley, Tmg. Blt. 1/5" Pitch 11 Groove Dwg. #6100E005	28:26:0187	1
	Pulley, Tmg. Blt. Plas. 1/5" Pitch 21 Groove	28:26:0250	1
	R3 - R:var:comp 10K 1/4W AB #YC103M	47:21:103C	1
	Screw, Flathead Phillips S.S. 6-32 x 3/8"	28:11:2604	4
	Spring, Belt Tensioning Dwg. #6100E013	28:02:0001	1
	Switch, POWER Rocker-slide 2PIT (Prod. Units)	51:52:0202	1
	Switch, Slide 2P2T (115-230VAC)	51:22:0201	1
	Transformer, power F & R #14M15-2	56:11:1248	1
	Transistor:Si NPN Power 2N4919	48:22:2032	1
	Transistor:Si PNP Power 2N4922	48:22:2029	1
	Vernier Assy. (includes flexible coupling)	21:41:0001	1